NATURE

No. 4335 SATURDAY, NOVEMBER 29, 1952 Vol. 170

CONTENTS

	Page
A Commonwealth Institute in London	899
Atomic Collision Processes. By Prof. H. W. B. Skinner, F.R.S.	901
Third European Brewery Convention. By Dr. E. Barton-Wright	901
Gmelin's Handbook of Inorganic Chemistry	902
Studies of Seven Central African Tribes. By F. B. Steiner	903
New Studies on Defective Colour Vision. By Prof. W. D. Wright	904
The International Council for the Exploration of the Sea. By R. S. Wimpenny	906
Foot-and-Mouth Disease Research in Great Britain	908
Technical Aids in Archæology. By E. M. Jope	909
Obituaries:	
Prof. H. E. Roaf	910
Dr. William Brown	911
News and Views	911
Wool Industries Research Association: Extension to Laboratories	915
British Standard of Radioactive Iodine (^{131}I). By Dr. E. C. Bullard, F.R.S.; Dr. Henry Seligman and John L. Putman	916
Structural Features of Antitumorigenic Corticoids. By Drs. Elvira Mardones, R. Iglesias, F. Fuenzalida, S. Bruzzone and Prof. A. Lipschutz	917
Passage of the Sperm and the Penetration of the Egg in Mammals. By C. R. Austin and A. W. H. Braden	919
Site of Action of Mutagenic Reagents. By Miss M. J. Ord and Prof. J. F. Danielli; Dr. E. B. Harriss, Dr. L. F. Lamerton, Miss M. J. Ord and Prof. J. F. Danielli	921
'Azidine' Transformations. By F. L. Scott, A. Koczarski and Prof. J. Reilly	922
Letters to the Editors:	
Total Synthesis of Flavin-adenine-dinucleotide.—S. M. H. Christie, Dr. G. W. Kenner and Prof. A. R. Todd, F.R.S.	924
Evolution of Animal Fats.—Dr. F. B. Shorland; Prof. T. P. Hilditch, C.B.E., F.R.S.	924
Anti-mutagens.—Aaron Novick and Leo Szilard	926
Agglutination Reactions in Human Red Cells Fragmented by Heat.—Ruth Ponder and Dr. Eric Ponder	928
Pseudo-Cholinesterase of Brain.—Prof. B. Mendel and D. K. Myers	928
Isolation of a Soluble Fibrinolytic Activator from Animal Tissue.—Dr. Tage Astrup and Agnete Stage	929
Rapid Restitution of the Rat Pancreas following Acinar Cell Necrosis Subsequent to Ethionine.—Dr. Patrick J. Fitzgerald and Dr. Mario Alvizouri	929
Acquired Resistance to Colchicine in a Strain of *Trichomonas vaginalis*.—Prof. S. Adler, A. Back and A. Sadovsky	930
Mode of Action of Chloramphenicol.—Dr. Ernst D. Bergmann and Sarah Sicher	931
Hypotensive Alkaloids of *Veratrum album*.—William L. Glen, Gordon S. Myers, Richard Barber, Paul Morozovitch and Gordon A. Grant	932
Transport of Substances through the Tentacles of Leaves of *Drosera capensis* L.—Prof. W. H. Arisz	932
Sex in *Pieris rapæ* L. and the Pteridin Content of their Wings.—Dr. Katashi Makino, Kiyoo Satoh, Masahiko Koike and Nsomichi Ueno	933
Diurnal Variations in the Blood Picture of Cattle.—R. N. T.-W.-Fiennes	934
Vapour Liquid Equilibrium Relationships in Extractive Distillation.—Dr. E. F. G. Herington	935
4-Deoxy-L Ribose.—P. F. V. Ward and Dr. P. W. Kent	936
Modified Newtonian Systems.—Dr. R. Capildeo	936
Hysteresis in Rubber.—D. M. Davies	937
'Detectivity': the Reciprocal of Noise Equivalent Input of Radiation.—R. Clark Jones	937
A New Dielectric Material.—Dr. L. Nicolini	938
Zoological Nomenclature.—Francis Hemming, C.M.G., C.B.E.	938
Recent Scientific and Technical Books	Supp. v

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office

A COMMONWEALTH INSTITUTE IN LONDON

IT is clear from the Minister of Education's foreword to the report of the committee of inquiry into the Imperial Institute* that no immediate action on the report is contemplated by the Government. Mr. K. G. Bradley (see p. 912) has been appointed director in succession to Sir Harry Lindsay, who retires at the end of this year, and one of the new director's first tasks will be to consider, in consultation with the Board of Governors and with the Government, in the circumstances then prevailing, on what lines the Institute should be carried on. The Minister gives no indication as to whether the Government is prepared to accept the essential conclusion and recommendation of Lord Tweedsmuir's Committee that the aims and organization of the Imperial Institute need drastic revision, in order to bring them into line with present-day conditions in the Commonwealth; and to reflect the recent transfer of responsibility for the Institute from the Board of Trade to the Ministry of Education, with its corollary that the major responsibility for financing the Institute must be assumed by the United Kingdom Government. The publication of the report should enable those immediately concerned to consider the proposals at leisure and to make appropriate representations in good time if necessary.

It will be remembered that when, in 1949, by Order in Council, the control of the Institute was transferred to the Ministry of Education and its purposes redefined on a mainly educational basis, the scientific and technical work of the Institute was transferred to the Colonial Office. The Institute accordingly no longer has the direct interest of the scientific worker or technologist which it formerly possessed, particularly during the period 1907–49. It is clear from this report, however, that in its adaptation to meet the new needs and conditions, the reconstituted Institute, particularly in its exhibitions in the galleries and in the cinema, and in its work as a centre for the dissemination of information and the discussion of problems relating to Commonwealth affairs, should continue to serve certain of their needs.

The Tweedsmuir Committee believes that the emphasis should shift from economic to social and cultural interests, and that the most important function the Institute could fulfil is to serve as a Commonwealth forum for the furtherance of mutual understanding among the members of Commonwealth countries by providing facilities for the presentation and exchange of ideas and information. To mark the change in outlook, it recommends that the name be changed to "Commonwealth Institute". To attain the new objective, it states that comprehensive reorganization of the exhibition galleries is necessary. The galleries, it is thought, should be divided into two main sections, one regional and national, the other illustrating the most important products and problems common to a number of

* Ministry of Education. Report of the Committee of Inquiry into the Imperial Institute. Pp. vi+40. (London: H.M. Stationery Office, 1952.) 1*s.* 6*d.* net.

Commonwealth countries. Besides special displays in the entrance hall and elsewhere, and periodic exhibitions illustrating topics of current Commonwealth interest, there should also be development on the fine arts side and a considerable extension of the existing provision for cinema and related displays. Further, a programme department should be established to co-operate with the exhibitions and social staff of the Institute in a discriminating expansion of the programme of lectures, classes, conferences and projects for adults as well as for school children.

The lecture services contemplated here include extension of the travelling lecture scheme outside London in collaboration with the other agencies in this field, and, on the social side, provision of various amenities, including restaurant facilities, reference library and reading room, as well as the establishment of a social club for students and regular users of the Institute. Careful consideration has convinced the Committee that even when such well-sponsored plans like that for the International House for the University of London have been carried out and hostel accommodation also becomes available for all Commonwealth students through schemes concerted by the British Council with the support of the Colonial Office, the need will remain for a place or places where Commonwealth students can spend their leisure or carry on their wider studies, in comfortable and attractive surroundings. The reorganization of accommodation recommended by the Committee should also make possible the offering of accommodation and facilities for meetings and discussions to outside responsible groups concerned with Commonwealth problems.

The Committee's proposals are imaginative as well as practical; and while the Committee is convinced that the provision of social amenities on a generous scale is vital to the success of the plan that is proposed, the main argument for it, and for continuing the Institute, is the urgent need for attracting and enlisting the interest of the ordinary citizen in the Commonwealth and its affairs. For this reason, the greatly improved publicity which is listed as the last of the Committee's proposals may well be the most urgent, and some steps to develop this side may be imperative in order to obtain public support of the new proposals. Even as it is, the Committee has been disturbed by the widespread ignorance of the aims and intentions of the Imperial Institute. The execution of the Committee's plans will involve a considerable amount of goodwill and co-operation which will scarcely be secured without full understanding of their purpose and the reasons for the Committee's recommendations, which are virtually for a new Institute.

The proposals of the Committee involve strengthening the technical and administrative staff, with a consequent increase of about £12,000 in the salary bill: the longer opening hours, including Sundays, and the higher standard of cleanliness, which are recommended, also involve considerable additions to the number of attendants and cleaners, with a further increase estimated at £3,000. This estimate ignores any substantial economies in caretaking and general upkeep which may well accrue from the modernization of the building and equipment, nor does it take account of increased cost of heating, lighting, etc., due to the use of a larger area and the longer hours of opening. It is anticipated that a loss of income of approximately £13,000 through discontinuance of the present practice of letting accommodation, which the Committee strongly condemns, will be partly offset by receipts from persons or bodies who avail themselves of accommodation or facilities offered in accordance with the Committee's proposals.

The Tweedsmuir Committee's proposals thus envisage an increased contribution from the Government, which is put at no more than £15,000, but which might rise to £20,000–£25,000 per annum if the expectation regarding revenue proved unfounded. This is not a large sum for purposes such as the Committee indicates; but whether at the present time of financial stringency it will be forthcoming is doubtful, unless more imagination and foresight are shown than has marked post-war government intervention in Commonwealth affairs. There is also a matter of capital expenditure for which the Committee recommends an initial five-year programme. The modernization of the existing premises, some of the equipment of which is regarded as more appropriate for a museum of antiquities, will have to be put in hand in the near future, whoever may be the new occupants. Besides this, it is recommended that the re-conditioning of the entrance hall, the re-grouping and reorganization of the galleries, the equipment of the Jehangir Hall, and the provision of amenities should be put in hand at the earliest possible date and completed within three years at the latest.

The Minister of Education's foreword to the report does not suggest that any urgency is attached to the matter by the Government; but it would not be right to infer from this that the comparatively small amount required to support so important a project will not be forthcoming. The proposals, however, in regard to accommodation may well involve major difficulties, for they require the return to the Institute, for use for its own purposes, of accommodation which has for long been in the hands of other bodies; and from its restrained criticism it is evident that the Committee is dubious as to the validity, let alone the desirability, of some of the arrangements made. The release by the University of London of the Central Entrance Hall and the Jehangir Hall is regarded as essential to the scheme, and could not wait on the re-building and re-organization already proposed when the University vacates the part of the premises it now occupies. Nevertheless, the Committee hopes that, in view of the amount of new accommodation acquired elsewhere by the University in recent years, it will regard with sympathy any request for re-adjustment of floor space, and that the whole of the west wing will revert to the Institute in the near future.

Finally, on the financial side, the Tweedsmuir Committee adds its own voice to those that in the past year or so have pleaded for some continuity of support for bodies engaged in research or in cultural

and educational activities. Any system of grant to the new Commonwealth Institute should be placed on a quinquennial basis. The scheme advocated in this report will be prejudiced from the start if those responsible for its execution only know from year to year what amount of money they can count upon from official sources, and are limited to budgeting expenditure on a rigid annual basis. There is no surer means of ensuring waste of public money than to adopt such a practice where research, cultural and educational activities are concerned. Nothing will indicate more clearly the sincerity of its belief in the value of promoting Commonwealth understanding and relations than the way in which the Government responds to this particular recommendation of the Committee; and on its main thesis, should the Government decide not to adopt the scheme, a reasoned statement and no mere *non possumus* is demanded by this carefully argued report.

ATOMIC COLLISION PROCESSES

Electronic and Ionic Impact Phenomena

By Prof. H. S. W. Massey and E. H. S. Burhop. (International Series of Monographs on Physics.) Pp. xviii+670. (Oxford: Clarendon Press; London: Oxford University Press, 1952.) 70*s*. net.

IN this volume, Prof. H. S. W. Massey and Dr. E. H. S. Burhop have provided an extremely complete compendium of results on the collisions of electrons and atoms. High-energy collisions and neutron collisions are deliberately omitted; but such problems as inter-atomic collisions, continuous X-ray production, and the collisions of electrons and atoms with solid surfaces are included, together with the more basic problems of the elastic and radiative collisions of electrons with atoms and molecules. The subjects are treated from an essentially experimental point of view, although considerable theoretical material is also included.

These topics were in the forefront of physical research in the 1920's and '30's. Indeed, a good deal of the material is that which did so much to help conventional spectroscopy to establish the quantum theory of atoms and atomic processes to its present state of completeness. Nowadays research on these subjects is out of fashion. We tend to think that if we took the trouble to work out the answers, we could explain the results of any fundamental atomic experiment. It is open to question whether such an attitude is sound. Among all the detail about the fundamental collision processes, not everything by any means has been satisfactorily explained. The book shows that there are a good many loose ends to be cleared up by some tidy-minded person. It will do a great service if such work is encouraged, for, in this field, good experimental work in atomic physics can be carried out comparatively cheaply. Such research is also an excellent training in accurate thinking on problems which are often basically simple.

I worked on electron collision problems in the late 1920's and early '30's, and it is a great pleasure to see work which I had almost forgotten (on the polarization of radiation excited in a gas at low pressure by a directed stream of electrons, and other problems of light-excitation) faithfully recorded in the volume. The work, though seeming elegant at the time, did not prove to be of any far-reaching importance, and is mentioned here merely as illustrating the by-ways into which the authors have strayed. In the context of the book, experiments of this type are seen in proper proportion as a part of the whole subject.

The work, besides presenting the fundamentals of a large part of atomic physics, also forms the basic raw material of applied work in gas discharges, in ionospheric problems and in astrophysics. The authors have been in the forefront of research in some of these subjects. This is probably the reason why they have taken the trouble to put all the scattered experimental results on collision problems into so comprehensive a form. Others may now have the benefit of their labours, and I am sure the book will be of great value to all those doing research in these applied fields. H. W. B. SKINNER

THIRD EUROPEAN BREWERY CONVENTION

European Brewery Convention

Proceedings of the Congress, Brighton, 1951. Pp. x+352. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1951.) 45*s*.

IT is the custom at the European Brewery Conventions to have one or more major themes for discussion: at the first Convention, which was held in Scheveningen, the subjects were of a general character; but at the second, which took place in Lucerne, the two highly important brewing problems of proteins in beer and the production of sterile beer by means other than pasteurization were the principal matters discussed. At the third Convention, which was held in Brighton in 1951 and the proceedings of which are here under review, the two main subjects chosen for discussion were: primary fermentation in the brewery, with special regard to the flocculation of yeast; and various aspects of the economic functioning of a brewery. The quality of the various papers read at Brighton was, on the whole, of a high standard, and some of the discussions animated and vigorous.

The subject of yeast flocculation is one of the utmost importance to brewers. In either top- or bottom-fermentation systems, unless a yeast is of a good flocculating type—that is, purges itself from the wort—the brewer may well be confronted with a number of harassing anxieties. This is especially the case with the brewing of draught beers with top-fermentation yeasts. If a yeast does not flocculate well, an unduly large and undesirable amount may be left in suspension in the beer, and thereby cause difficulty in fining and subsequent 'frets' in cask. So far as bottled ales are concerned, this question of yeast flocculation is not of such paramount importance, because the beer is submitted to a drastic process of filtration. Even so, when a poorly flocculating yeast is used for the fermentation of bottled beers, heavy 'bottoms' in the storage tanks can lead to serious losses.

The whole question of flocculation is bound up with the physical behaviour of a yeast in the fermentation vessel, whether the yeast be a top or bottom strain. Thus, a yeast which tends to come

out of suspension rapidly is termed a flocculating yeast, whereas a yeast which separates slowly and tends to remain in suspension is called a non-flocculating or 'powdery' yeast.

The two most outstanding papers which were read in this part of the Convention were given by R. S. W. Thorne (Brewing Industry Research Foundation) and R. B. Gilliland (Arthur Guinness, Son, and Co., Ltd.), and it is difficult to do them adequate justice in a short review. Thorne, using the hybridization technique devised by Winge, showed that flocculation is under genetic control, having found that flocculation is dominant to non-flocculation. The genetic control of flocculence, however, is complex and, apparently, no less than three pairs of polymeric genes are concerned in the process, any one of which is sufficient to confer flocculence on a yeast which happens to possess it. Thorne claimed also that the genes controlling flocculence apparently mutate spontaneously at an astonishingly high rate to the non-flocculating type. Gilliland's contribution to this subject was more concerned with flocculence under brewery conditions, and he was able to distinguish four types of yeast isolated from a mixture used in top-fermentation brewing, which differ in various characteristics—for example, times of flocculation in worts. Gilliland claimed that a single gene segregation controls flocculence. There is, however, no real conflict between this observation and that of Thorne, because it may well be that these apparently conflicting results are due to differences that exist between different strains of yeast. On the other hand, there was a real difference of opinion between these two workers on the question of the incidence of mutation, Thorne holding the view that mutation is rapid and Gilliland that his strains are stable.

The foreign visitors to the Convention, which included such distinguished brewers and brewing chemists as Dr. B. D. Hartong (Holland), Prof. J. de Clerck (Belgium) and Dr. B. Trolle (Denmark), naturally enough discussed the question of yeast flocculence from the angle of bottom-yeast fermentations. Unfortunately, it has not proved possible up to the present time to hybridize bottom yeasts, and therefore the question of genetical control of flocculence in bottom-yeast strains has not been elucidated.

The economic functioning of a brewery forms no part of a review of this nature, but a number of interesting papers on miscellaneous subjects connected with brewing were also read. Two outstanding papers of general scientific interest were given in this section of the Convention. Prof. I. A. Preece (Edinburgh) dealt with the non-starchy polysaccharides of barley and their influence on wort composition, and Drs. G. Biserte and R. Scriban (France) discussed the proteins of worts. According to Preece, the bulk of these non-starchy polysaccharides are derived from the endosperm of the grain, and the proportion of cold-water soluble material obtained from barley appears to be a varietal character. Biserte and Scriban have made an elaborate study of the amino-acid and peptide fractions of wort, and have been able to separate by differential electrophoresis of the sodium chloride extracts of barley and malt a number of protein fractions which are also present in wort.

In conclusion, it can be said that this was a very good Convention indeed, and worthily maintained the high standard set by its two predecessors.

E. Barton-Wright

GMELIN'S HANDBOOK OF INORGANIC CHEMISTRY

Gmelins Handbuch der anorganischen Chemie
Achte völlig neue bearbeitete Auflage.
Herausgegeben vom Gmelin-Institut in Clausthal-Zellerfeld. System-Nummer 3 : Sauerstoff. Lieferung 2, Vorkommen ; Technologie. Pp. 83–300. 65 D. marks. Herausgegeben vom Gmelin-Institut für anorganische Chemie und Grenzgebiete in der Max-Planck-Gesellschaft zur Förderung der Wissenschaften. System-Nummer 27 : Magnesium. Teil A : Geschichtliches, Vorkommen, Bildung und Darstellung, Physikalische Eigenschaften, Elektrochemisches und chemisches Verhalten, Nachweis und Bestimmung, Legierungen ; Lieferung 4 : Legierungen von Magnesium mit Zink bis Rhenium, Oberflächenbehandlung. Pp. xiv+483–818. 100 D. marks. System-Nummer 41 : Titan. Pp. xxii+481. 113 D. marks. System-Nummer 17 : Arsen. Pp. xv+475. 140 D. marks.
(Weinheim/Bergstrasse : Verlag Chemie, G.m.b.H., 1951–52.)

THE steady progress in the publication of "Gmelin" is a praiseworthy and pleasing event. The work has proved of the very greatest value, and new volumes are always welcome. A detailed review here of such a work is impossible, and only a few main features of the parts named above can be sketched. This should not be regarded as minimizing its importance ; but since the treatise is so well known and highly regarded, it seems superfluous to enlarge upon its merits.

The volume on oxygen, which deals with its occurrence and technology, includes the occurrence of free oxygen and ozone in the atmosphere at all levels, and the distribution of combined oxygen in the lithosphere. There is also a section on water from the same points of view. These will interest many kinds of readers besides chemists. The technological part deals not only with oxygen but also with ozone and with the purification of water and the production of hydrogen peroxide. Much patent literature is covered. The information on the technical production of pure hydrogen peroxide may be singled out for special mention.

The volume on magnesium alloys includes a long section on surface treatment. This field is of great technical importance ; but a remark made in a previous review as to whether the completion of the purely chemical part of the book should be delayed by the issue of metallurgical and technical volumes may be repeated.

The volume on titanium, which is preceded by a portrait of Roger Adams and a dedication of the book to him in recognition of his timely support, deals with a subject of great present interest. Whether the claims made for the technical future of titanium will be justified, time alone can show ; but to the chemist the volume, which appears to be complete, will be of great interest. The occurrence of the element, the preparation of the pure metal and its compounds, and details of their physical and chemical properties, are all covered to the end of 1949. The treatment is modern. The reader will perhaps be struck with the small space occupied by the descriptions of the chemical properties as compared with the physical, and this tendency should not be carried too far. A book on chemistry should lay special emphasis on the purely chemical aspects of its subject. On

titanium monoxide, for example, there are five and a half pages on physics, including nearly three on spectra, and only nine lines on its chemistry. On titanium dioxide there are twenty pages on physical properties and only four on the chemical. The writers should see if they cannot find something more to say on chemistry.

The volume on arsenic is very detailed and complete. The sources are given fully, and as much space is given to some of little importance as to the main ones. Some attempt should be made to condense in such sections. There are eighty-three pages on occurrence, which is too lavish. A little more could have been said on the allotropic forms, although pages 116–122 are good so far as they go. The physical properties again occupy much more space than the chemical throughout, but the latter are given in more detail than in some other volumes. The hydrates of arsenic pentoxide are adequately considered. The action of light on arsenic disulphide is not sufficiently emphasized, and museum curators, for all they will find here, can still wonder why their specimens do not keep. Optical properties such as principal refractive indices and axial angles do not seem to be given where they might have been expected.

STUDIES OF SEVEN CENTRAL AFRICAN TRIBES

Seven Tribes of British Central Africa
Edited by Elizabeth Colson and Max Gluckman. (Published on behalf of the Rhodes–Livingstone Institute, Northern Rhodesia.) Pp. xx+410+28 plates. (London, New York and Cape Town: Oxford University Press, 1951.) 37*s*. 6*d*. net.

THE book consists of the following seven essays: Prof. H. M. Gluckman on the Lozi, Dr. E. Colson on the Plateau Tonga, Dr. Audrey Richards on the Bemba, Mr. J. A. Barnes on the Fort Jameson Ngoni, the late Godfrey Wilson on the Nyakyusa, Dr. J. C. Mitchell on the Yao, and Dr. J. F. Holleman on the Hera, Rowzi and Mbire of the Zezuru tribal cluster of central Mashonaland. The tribes are Central African in a vague geographical sense, and all speak Bantu.

"Our plan," the editors write in their preface, "was to produce a general description for each tribe which might be useful to officers working in the region and which could be used by students of anthropology who wished for some knowledge of the types of social organization to be found in the area." This collection of essays, which is intended to serve as a monument of the first eleven years of research planned and carried out by the Rhodes–Livingstone Institute, addresses itself primarily to two small groups of specialists and not to the general reader with sociological interests; the latter would find himself insufficiently equipped to deal with these, at times, severely technical essays in African tribal structure. As exceptions must be noted two essays which are slightly altered reprints of articles by Dr. Audrey Richards and the late Godfrey Wilson—the only essays which are not written by the Rhodes–Livingstone research team, and its successive leaders since the Institute's expansion. The editors must be congratulated on having departed from a programme of uniform presentation so far as to include these studies, the omission of which would have deprived the collection of its two fullest ethnographic accounts. Dr. Richards's essay (first published in 1935), in its admirable economy of exposition, is perhaps the best study of the Bemba, a tribe living on the plateau-land of north-eastern Rhodesia, to the study and description of which she has devoted many years.

By far the longest contribution is that of Prof. Gluckman on the Lozi, the ruling tribe of the Barotse nation (in the author's use of the two terms) of the Barotse Plain in North-western Rhodesia, a semi-pastoral group, who have marked cultural affinities both with the Southern Bantu and the peoples of the southern Congo basin, and who, living in the curious habitat of a Central African flood-plain, developed a very complex horticultural economy. The essay is divided into three chapters—Barotseland and the Barotse people (which includes class and tribal divisions); kingship, nation and land; and land, state, village and kinship—from which it can be seen how much the essay concentrates on the tribal political institutions. The centre of these is kingship, the main theme of the essay. Prof. Gluckman has written on several levels of analysis what surely is one of the most important sociological monographs on Bantu kingship.

Tonga as a linguistic term implies a main division of the zone of Central Bantu languages. Apart from the Ila- and Tonga-speaking population, "written material on any of these peoples is lacking". As in the case of the latter this material was scanty, information is very welcome. Dr. Colson, Prof. Gluckman's successor at the Institute, has selected for her research a part of these Tonga-speaking peoples, the Plateau Tonga, a population which has never formed a political group and which can be distinguished only in terms of their location and of the units of the present administration. They are one of the three matrilineal societies dealt with in this book, along with the Bemba and Yao. The description of the village unit is sketchy, that of the family and kin groups informative, and the analysis of the linking of matrilineal groups has many points of interest.

The Ngoni migrated north from Natal in 1820. Their state, of the type familiar from Zululand, was defeated by British forces in 1898, and this caused the decline of the central authority and of the regimental system, and some segmental autonomy. The breaking-up of political institutions, work on European farms and migrant labour are the background against which Mr. Barnes had to study Ngoni life. Dr. Mitchell's Yao, too, represent a "changing culture" in that sense. His investigation, that of the matrilineal system in particular, seems such a solid and imposing achievement that his book will be awaited with impatience.

Dr. Holleman's report on the Shona lacks the definiteness of the other contributions and might more suitably have appeared in a periodical. The report directs the reader's attention to the fact that little is known about this group of tribes, even on the ethnographic level to which the report keeps.

Each essay is followed by a most useful bibliography.

The collection is dedicated to Dr. Edwin W. Smith, co-author of the classic on the Ila-speaking peoples. The editors' few and dignified words of gratitude will be appreciated by all Africanists. The book seems worthy of bearing such a dedication.

F. B. STEINER

NEW STUDIES ON DEFECTIVE COLOUR VISION*

By Prof. W. D. WRIGHT
Technical Optics Section, Imperial College of Science and Technology, London

During the past few years, there has been a very lively interest in the subject of colour. This has derived in part from its increasing technical importance in the colour industries, while the introduction of the fluorescent lamp and the development of colour television have brought out new problems to be solved and new groups of scientific workers and engineers anxious to solve them. At the same time, there has been a great deal of interest in colour vision as a subject worthy of study in its own right, and speculation is still rife regarding the visual processes responsible for colour perception.

There is, unfortunately, plenty of room for speculation, since we are still ignorant of the visual mechanism by means of which an observer can distinguish one coloured light from another. When an image is focused on the retina, the reaction in the receptors must vary qualitatively when the wave-length of the light is changed; only thus can the brain receive signals which can be interpreted in terms of different colour sensations. It is generally believed that the characteristic messages to the brain originate in different types of receptor in the retina, one type being most sensitive to one part of the spectrum, another type to another part of the spectrum, and so on. The pattern of activity in the receptor types would then provide an effective means for differentiating one coloured stimulus from another.

So far, however, it has been impossible to complete this picture with objective information about the receptors. The three main methods of attack—histology, photochemistry and electrophysiology—have provided clear distinctions between the rods and the cones; but although Granit has recorded a variety of spectral sensitivity curves on various retinæ using a micro-electrode technique, it has not been possible so far to link these up with different photo-sensitive substances in the cones or with different cone structures. It is not impossible, as Willmer has suggested, that the division of the receptors into rods and cones may itself form the basis of a colour-discriminating mechanism; but the orthodox view is that colour perception is a purely cone function. We must hope that in due course the physiologists will be able to find ways and means of identifying different types of cone; but we have to recognize that their task is extraordinarily difficult and will require very refined techniques.

Since we are ignorant about the processes responsible for normal colour perception, we can scarcely hope to explain its abnormalities; but a curious position exists in that a great mass of quantitative data has been recorded on the characteristics of normal and defective colour-vision. In some respects, indeed, a very clear relationship has been established, and it is baffling not to be able to link this relationship to its physiological counterpart.

Various kinds of colour vision test can be carried out, and my own experience has been largely concerned with measurements made on a colorimeter in which two halves of the field of view are illuminated by monochromatic radiations selected from two spectra. In experiments on wave-length discrimination, for example, both fields are illuminated with single monochromatic lights of the same wave-length λ; one of the wave-lengths is then changed by a small amount $\Delta\lambda$ until a difference in hue can just be detected by the observer, the luminosities of the two beams having been kept equal. Or again, the sensitivity of the observer to lights of different wave-length can be tested by finding the energy $e\lambda$ required in one half of the field to produce a light sensation of constant magnitude as judged by making a luminosity match against a constant stimulus in the other half of the field, or by some other equivalent technique. In colour matching, one half of the field can be illuminated by a mixture of three monochromatic radiations taken from the red, green and blue parts of one of the spectra, and their proportions can be varied to give a colour match of the test colour in the other half of the field derived from the other spectrum.

Measurements of this type can take a considerable time and are unsuitable for the routine testing of large numbers of people; but they have the very great advantage that the light stimuli in the experiment are physically simple, and it is possible to study each variable of colour vision in turn.

When the results for those with normal and defective colour-vision are compared, one of the most important distinctions that is noticed is the relatively poor wave-length discrimination of the defectives. In an instrument in which the observer views a 2° field, the normal subject can distinguish some 150 different hues through the spectrum, whereas the defective may see only half this number or less, depending on the degree of his defect. This is not, however, due to a general lowering of colour discrimination, but to a reduction or total absence of discrimination in some parts of the spectrum, while in other regions discrimination is virtually unimpaired. Thus in the so-called red–green defect, radiations from the red–yellow–green spectral region may appear identical when luminosity differences are eliminated.

While poor colour-discrimination is perhaps the feature which is pre-eminently characteristic of defective colour-vision and is also the cause of most of the practical disabilities associated with the defect, other significant characteristics also emerge from experiments with a trichromatic colorimeter. The most striking is that, while a normal observer has to mix three radiations in order, in general, to make colour matches, it is found that some defective observers need to operate only two controls, while a very small number of persons exist who can do all their colour matching by operating a single photometric control. These three types of observer are known as trichromats, dichromats and monochromats respectively; and, while a considerable proportion of colour defectives have vision intermediate between dichromatism and normal trichromatism, it is with the dichromats that this article is especially concerned.

The natural explanation of these three forms of colour vision is that the normal retina possesses three kinds of colour receptor, the dichromatic retina two,

* Substance of a Friday Evening Discourse given at the Royal Institution on May 2.

and the monochromatic one. If one of the three receptors were inactive, we should expect that the dichromat would show an abnormal spectral sensitivity, and indeed in protanopia (the defect which is usually attributed to the absence of red receptors) the sensitivity curve is very low at the long-wave end of the spectrum. In deuteranopia, the sensitivity curve is very similar to the normal curve, and the defect can be explained on the assumption of a fusion of the red and green processes at some stage in the visual pathway from retina to brain.

This explanation of these two forms of defect is supported by a more detailed study of the protanopic and deuteranopic colour confusions. The usual method of specifying a colour for a normal observer is based on the Maxwell colour triangle, which in its modern form has rectangular co-ordinates and is termed a chromaticity chart. A colour is specified in this chart by the proportions in which defined red, green and blue stimuli have to be mixed additively to match it ; but for dichromatic vision the chart has one variable too many. Helmholtz investigated this subject theoretically and showed that, for an observer whose red receptors were missing, there should be a series of isochromatic zones across the colour triangle radiating from the red corner and that, for such an observer, all colours lying in a given zone would be confused, while colours from different zones would be distinguished. Many years later Pitt showed experimentally that the protanope confusion zones do radiate from a point in the red corner of the chromaticity chart, whereas the deuteranope zones are more nearly parallel, a result that provides some of the strongest evidence that the former defect is due to a missing red process and the latter to a red–green fusion.

Theoretically, various other forms of dichromatism might exist ; but only a form in which the blue process is believed to be inactive, and to which the name of tritanopia has been given, has received much attention. A few cases of tritanopia have been reported in the literature, but, as they have usually been associated with some pathological condition of the eye, the existence of congenital tritanopia has been a matter of doubt. Certainly no data on tritanopia comparable to the information on protanopia and deuteranopia have been available.

I should, however, mention here that in a sense we are all tritanopes, since, for some reason not yet understood, small-field vision—that is, vision when viewing objects subtending 20′ arc or less and especially when imaged on the fovea—tends to become tritanopic. Some interesting data on small-field tritanopia have been recorded during the past few years, following the rediscovery by Willmer in 1944 of the phenomenon which had first been investigated by König fifty years earlier. Nevertheless, there is still great theoretical and practical interest in the investigation of congenital tritanopes, if such are to be found.

That was the position in May of last year, and if tritanopes were as rare as one in a million, as had been suggested, normal methods of testing were unlikely to produce many of them in any reasonable space of time. Unexpectedly, however, an opportunity for mass testing presented itself through an article on colour blindness which Mr. D. Wragge Morley was preparing for the magazine *Picture Post*. He intended to include some coloured reproductions of the well-known Ishihara charts which are widely used for detecting the red–green defect, and it happened that Lieut.-Commander D. Farnsworth, from the Medical Research Laboratory of the United States Naval Submarine Base, had in 1947 given me a chart designed on the same principles as the Ishihara charts but in colours that would demonstrate small-field tritanopia. It seemed that this chart might also serve to detect congenital tritanopia, and, at my suggestion, Mr. Morley kindly included a reproduction of it in his article.

Readers were invited to report any difficulty they had in reading the Farnsworth chart, and, out of a *Picture Post* readership said to be more than nine million, some nine hundred letters were received. As it turned out, these letters were in many cases from red–green defectives who were unable to read the ordinary Ishihara charts, while many more were from persons who were probably partial tritanopes. About forty, however, were from people who appeared to be genuine tritanopes.

The selection of the tritanopes was based partly on the way they described their reaction to the Farnsworth chart and partly on other evidence they supplied about their defect. For example, a number of the letters mentioned that, when playing the game of snooker, the writers tended to confuse the brown, green and red balls ; these people were evidently red–green defectives. One correspondent, on the other hand, reported that he sometimes confused the blue and green balls and sometimes, too, the yellow and pink ; these are just the confusions associated with tritanopia, and subsequent tests proved that he was, in fact, a tritanope.

For various reasons, in particular that of distance from London, not all the suspected tritanopes could make confirmatory tests in the laboratory, but seventeen cases were confirmed, and, of these, seven made a number of visits during the next few months for a series of observing sessions. Records were made of their curves of spectral sensitivity, colour mixture, wave-length discrimination and confusion loci in the chromaticity chart, the details being later published by the Optical Society of America (*J. Opt. Soc. Amer.*, 42, 509 ; 1952). The results confirm that tritanopes can do all their colour matching by the additive mixture of a red stimulus with either a green or a blue stimulus, wave-length discrimination disappears in the green to blue spectral region, and the colour-confusion zones tend to radiate from the blue corner of the chromaticity chart. All this is in agreement with the hypothesis that the defect is due to the absence of blue receptors, although the mean spectral sensitivity curve did not appear to be significantly lower than the normal at the short-wave end of the curve.

The incidence of tritanopia was evidently rather higher than one in a million ; but, if an estimate were to be made, it was necessary to guess at the fraction of tritanopes who had bothered to reply to the article in *Picture Post*. After discussion with Mr. A. J. Burkart, of Hulton Research, I felt it was safe to assume that probably at least 5 per cent and at most 25 per cent of the tritanopes might have been expected to respond, which would put the incidence of tritanopia somewhere between 1 in 13,000 and 1 in 65,000. This is very much less than 2 per cent of red–green dichromats found among men and even the 0·12 per cent of women.

Another interesting feature was the proportion of men to women tritanopes, which worked out at 1·6 to 1·0, whereas in the red–green defect men outnumber women by 16 to 1·0. Here the large number

of red-green defective correspondents were of value, for among them were 354 men and only 27 women, showing that the higher proportion of women tritanopes was not an artefact arising from any disinclination of men to write in and report on their vision. Evidently the transmission of tritanopia from one generation to another must differ from that for protanopia and deuteranopia.

I should like finally to refer to the social aspects of defective colour vision, since the very interesting correspondence which I had as a result of the *Picture Post* article confirmed that a real social problem exists. A few years ago the Physical Society Colour Group published a report on defective colour-vision in industry in which a survey was made of the occupations in which good colour-vision is necessary. If a colour-defective person enters such an occupation, he may later find himself barred from promotion or even relieved of his job altogether—a misfortune which could have been avoided by a pre-vocational test. The industries affected are not merely the colour industries, such as dyeing, paint and printing, but many others, like radio and electrical engineering, where colour codes are used extensively. Or again, in occupations such as agriculture and horticulture, the picking, and judging the quality, of tobacco, tomatoes, apples, cotton, bananas, etc., has been shown to need surprisingly good colour-vision.

My recent correspondence has re-emphasized the desirability of colour tests, not merely from the point of view of industrial efficiency, though this aspect should not be ignored, but rather as a form of vocational guidance to avoid personal distress and economic hardship. If testing of the colour-vision could be included as a regular item in the school medical inspection, as the Physical Society Report advocated, most of the difficulties could be anticipated and avoided.

Many people have been fascinated by the subject of colour, and since the basic problems of colour perception are still unsolved, its scientific attraction is likely to be maintained for a long time to come. Its social implications make its study even more worth while.

THE INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

By R. S. WIMPENNY
Fisheries Laboratory, Lowestoft

ON the twenty-fifth anniversary of the International Council for the Exploration of the Sea, the late Mr. H. G. Maurice, then in the mid-period of his long and lustrous presidency, said that the Council was a plant sown in Sweden, which had germinated in Norway and flowered in Denmark. It is therefore worth casting back to the origins of the distinguished and long-established international body which celebrated its jubilee early in October.

To begin with, it must be recalled that, throughout the 'eighties and 'nineties of the past century, there had been a great increase of fishing by the nations bordering the North Sea. Men like Thomas Huxley had earlier expressed views on the inexhaustibility of fish stocks, and these opinions were widely held. In spite of this, however, the fishermen working nearest the shore had reason to disagree, and their doubts were beginning to reach their Governments. It was, then, this feeling of the possibility and even likelihood of impoverishment of the North Sea that provided the convenient seed-bed for the flower referred to by Mr. Maurice.

The initial step in the Council's formation was taken by King Oscar II of Sweden, who called an international conference in Stockholm in June 1899 to consider international exploration of the Arctic, the North Sea and the Baltic, in the interests of the fisheries. Largely based on the King's suggestions, a programme dealing with hydrography, biology and the organization of a central bureau was agreed. At a further conference held in Christiania in May 1901, the Stockholm programme was confirmed and extended.

The first establishment took place at Copenhagen in July 1902, when Germany, the United Kingdom, Denmark, Finland, Norway, Holland, Sweden and Russia were the founder members. With the exception of Russia, all these countries are members to-day; but in addition there are France, Belgium, Spain, Portugal, Iceland and Ireland. The Council was constituted of two delegates from each country and an executive committee called the 'Bureau', consisting of the president (Dr. W. Herwig), the vice-president (Dr. Otto Pettersen) and the secretary-general (Dr. P. P. C. Hoek). Nowadays, the Bureau has a 'first vice-president' and three other vice-presidents; otherwise the constitution remains much the same.

Under the Bureau at Copenhagen, there was appointed a hydrographical assistant, Dr. M. Knudsen, and a biological assistant, Dr. H. M. Kyle, while at Christiania there was set up a central laboratory under Prof. Fridtjof Nansen. The Christiania laboratory was to close down in 1907, but the post of hydrographic assistant continues to this day under Dr. J. Smed, successor to Dr. Knudsen.

The first working committees were three in number, one under the chairmanship of Prof. J. Hjort to study the migrations of fish, the second under Dr. W. Garstang to study the question of over-fishing, and a third under Dr. O. Nordqvist to study the biology of the Baltic. In the course of time, however, the increase in the area covered and the subjects investigated has brought about a considerable increase in these committees, so that at the last meeting there were in session sixteen committees and sub-committees, not to mention a steering committee called the Consultative Committee. This latter is composed of the chairmen of the other committees and was established after the First World War in order to secure an orderly arrangement of business at the Council's annual meeting.

From the start, or soon afterwards, the Council has been responsible for the issue of a number of publications. These were the series *Bulletin Hydrographique*, *Bulletin Statistique* and *Bulletin Planktonique*, *Publications de Circonstance* and *Rapports et Procès Verbaux*. The *Bulletin Planktonique* no longer appears, and the *Publications de Circonstance* were replaced in 1926 by the *Journal du Conseil*, but the remainder continue.

Between the date of foundation and the outbreak of the First World War was a period of great and well-integrated international effort in the North Sea. This consisted of regular hydrographic, plankton and trawling surveys of great descriptive value. The trawling work in particular resulted in a knowledge

of the natural history of the plaice, to which little has been added since.

While up to that time no great advance had been made in our ideas on over-fishing, the confirmation that the European coastal grounds were nursery areas for plaice resulted in a proposal for their closure in the interests of the plaice fishery. A more striking result was the demonstration that young plaice from the coastal grounds grew up to three times as fast when transplanted to the Dogger Bank. Although there have been repeated demands for putting plaice transplantation into effect on a commercial scale, to make a substantial alteration to the fishery would involve doubling the population density on the Dogger Bank by moving about 15,000,000 small plaice. Up to the present, the practical difficulties of transport, particularly that of avoiding mortality in transport, have not been solved. Large-scale experiments have, however, been made by Denmark and are contemplated by Britain.

As there was no agreement on conservation by the closure of young plaice grounds between the two World Wars, the idea of sparing young fish by using larger meshes gained ground. A special meeting dealing with mesh experiments was held by the Council in 1934, and at another in 1932 an old argument against the conservation of young fish, which held that their removal produced a compensating greater growth of those that were left, was demolished.

Shortly before these meetings, Dr. E. S. Russell published in the *Journal du Conseil* a simple formulation of the factors responsible for the behaviour of an exploited fishery as they had been described by earlier workers. This was followed in 1935 by a more mathematical exposition of these factors by Mr. Michael Graham, who deduced that in the year in which he wrote the same yield could have been taken out of the North Sea by substantially less effort.

As a result of this and other work, international conventions to regulate the sea fisheries were drawn up in 1937 and 1946. Both recommended increased minimum sizes of the mesh for trawls and seines, and that of 1946 would doubtless have gone further had it been possible to give equivalents for the various and different offers of relaxations on fishing made by the different nations. In order to help to provide some of this necessary information, the Council arranged a special meeting in 1948 on the comparative efficiency of fishing vessels, their gear and parts of gear. Thereafter, a special sub-committee was set up to deal with the subject, and extensive and appropriate programmes were initiated, which are being carried out by several countries.

A part of the programme just mentioned involved under-water photography of trawls and seines, and one of the most important features of the Council's jubilee meeting in 1952 was the display of two films. One of these was from the Ministry of Agriculture and Fisheries and showed the behaviour of trawls under water near Malta. The other showed the behaviour of plaice about to be caught in the mouth of a Danish seine net used by the Fisheries Research Section of the Scottish Home Department in the shallow water of the Moray Firth.

Of more than sixty papers presented at this meeting, one of the most relevant to the Council's work was a contribution by Mr. R. J. H. Beverton on the principles of fishery regulation. This brought the mathematical formulation of rational fishing up to date with the inclusion of the post-war work of Beverton and Holt, and it is clear that more than a good guess as to how to obtain the biological optimum from the sea is now available. For the rest of the story of rational exploitation, shore economics and administrative policy will be responsible.

It is now quite clear that relaxations of fishing effort can be weighed and made equivalent, so that any proposals made by North Sea nations on the new Permanent Commission, designed to be set up as soon as the 1946 Convention is ratified, will be understood and transformable into the means of getting the same or a greater yield from the area with less effort.

There was much other material in the 1952 meeting which was in support of the main biological theme, but it is perhaps more profitable to notice that the greater part of the hydrographic contributions were offered to biological committees. This represents a desirable convergence between the long-established hydrographical and biological aims of the Council, which has become evident in the past few years.

In the early days hydrography had much of its own story to establish and describe; although, even then, the long-term cycles of the Baltic herring fishery were thought to have a direct hydrographic cause. However, as time went on, the relation with biology became closer and more obvious.

Slowly, in the period between the two World Wars, we had evidence of the warming up of the waters of the northern hemisphere, one of its consequences being the establishment of our great cod fishery in the Barents Sea, which only dates from 1928. Since the Second World War we have seen the cod spread and increase in Greenland waters so that, in the North Western Committee of the Council, Dr. Paul Hansen has been able to report that this species now breeds in west Greenland waters and does not rely on recruitment from Iceland.

It is with matters of this sort, and also in the detailed analysis of water movements, such as those responsible for the distribution of plaice eggs and young fish from their spawning grounds in the south-west North Sea to the nursery grounds on the Dutch, German and Danish coasts, that the hydrographers of the Council are at present engaged. They will doubtless have much similar work in the future, and there is no doubt that the series of synoptic charts of the monthly salinity, temperature and wind values for the waters of north-west Europe, which the Hydrographer of the Council took over from the Ministry of Agriculture and Fisheries at the last meeting, will be of great help to fisheries biologists.

Of special importance, however, will be the possibility of obtaining from the hydrographers information on winds, currents and temperatures which will enable fishery biologists to obtain not only forecasts of good fish broods and their distribution, but also the long-term prospects of a fishery.

Will the newly established Arctic fishing area continue to grow in extent, or have we to anticipate its recession? What are the hydrographic conditions in the sea that govern the shoaling and migration of fish? If we lose a commercial species in one area, can we find it again elsewhere or replace it by another? These are the sort of questions related to hydrography to which we expect to see complete or partial answers given at future meetings of the Council, as well as the biological ones as to the

behaviour of a stock of fish in relation to its degree of exploitability by man.

Most of the great names associated with the Council's inception are those of men who are now only memories; but it is happy to be able to record that Prof. H. H. Gran, who was responsible for much of the plankton work in the early days, was present at the jubilee meeting. The retiring president, Dr. K. A. Andersen, of Sweden, laid down his office as president after many years of close association with the Council's work.

The new president is Mr. A. T. A. Dobson, of the United Kingdom, and the new Bureau includes Prof. Jean le Gall (first vice-president, France), M. Lienesch (Holland), Prof. H. U. Sverdrup (Norway) and Dr. Vedel Tåning (Denmark). Mr. Michael Graham (United Kingdom), who resigned the chairmanship of the Consultative Committee for reasons of health, has been succeeded by Mr. R. S. Wimpenny (United Kingdom).

FOOT-AND-MOUTH DISEASE RESEARCH IN GREAT BRITAIN

An interim report on the research work carried out on foot-and-mouth disease at the Research Institute, Pirbright, has recently been published by the Agricultural Research Council*. The report deals only briefly with the many researches already done and the activities now in progress; this publication, however, is timely for, although some excellent scientific papers have been published from the Institute, they may not be available to the general public in Great Britain, who, naturally, are much interested in research work on foot-and-mouth disease. On this point the Lord President of the Council, in the foreword, says, "I have instructed that this Report be published and widely circulated in the hope that public interest may be informed and stimulated about a problem to which scientists are earnestly seeking a solution". We are promised a comprehensive report in the spring of 1953.

The position now held by the Pirbright Institute, the reliance placed on its work, the services rendered to other countries and the knowledge which is being built up, amply justify the existence of the Institute, which is generally conceded to be the most important centre in the world at which research work is carried out on this widespread disease. Mention may be made of only a few of the results of past and present work to justify this claim. It was at Pirbright that the complement-fixation test, now acknowledged widely as a reliable and rapid method of determining the immunological types of virus strains, was developed. Improvements have been made on the test to an extent that "it is now possible by this method to determine the type of virus involved, within a few hours of the receipt of material from a suspected outbreak". The value of this work cannot be overestimated, especially for countries in which a vaccination policy is in operation, for the vaccine to be used will depend upon the type of virus recovered from the infected animals. The occurrence of variant strains or sub-types of foot-and-mouth disease virus was established at Pirbright when the Institute was assisting a Mexican – U.S.A. Commission some years ago in studying the widespread outbreaks in Mexico. The control of the recent outbreaks of the disease in Europe has been made difficult by the appearance of variant strains which show significant differences when vaccination is being considered. It was at Pirbright that carefully controlled experiments on cattle showed that vaccine produced from virus cultured in tongues of healthy cattle slaughtered for food produced results as satisfactory as those with vaccine prepared from virus obtained from the tongues of cattle artificially infected with the virus. Although this more recent method of preparing vaccine was not worked out at Pirbright, but in Holland, it was the workers at the Pirbright Institute, using the facilities there, who showed quite definitely the value of the vaccine. This method obviates to a large extent the use of living cattle, and thereby results in a very considerable reduction in the costs of vaccine production.

The Pirbright Institute holds stocks of freeze-dried, diagnostic and typing sera and sends them on request to any country; since 1949 the income from the sale of these sera has been 10,000 dollars. The provision of such sera is an important part of the Institute's work. They are not easily produced, and their value to a country for purposes of diagnosis is great. In addition, it is possible by the use of reliable sera to differentiate not only between types and strains of foot-and-mouth disease virus, but also between these viruses and the agents causing diseases presenting somewhat similar clinical symptoms. It was, for example, by using Pirbright methods and sera produced there that a recent outbreak of disease in Canada was shown to be foot-and-mouth disease and not vesicular stomatitis, as was originally suspected.

Work on the preparation of vaccines for the prevention of foot-and-mouth disease is also carried out at Pirbright. In all, 135 vaccines have been prepared there during the past ten years, by eight different methods. Although vaccination is not practised in Great Britain, any improvement on foot-and-mouth disease vaccines is of value and interest to other countries. The more efficient the vaccine, the better will be the control of the disease in countries which adopt a vaccination policy, and, therefore, the reduction of the risk of infection being introduced from them into Great Britain. It is of much interest to note that, from experiments at Pirbright, it can now be said that "Present evidence suggests that full protection could be given for about four months. After this period an increasing proportion of vaccinated animals would become susceptible to the disease".

A finding of much practical importance by the Pirbright workers concerns the survival of the virus in meat and offal. Precise experiments have shown that some early observations that infection in an affected animal was largely confined to bone marrow have had to be revised, for "there is an equal risk of other tissues, including the lymph nodes, blood in the large vessels, liver, kidneys and the rumen, remaining infective for long periods". The significance of these findings is of the greatest importance to countries which import meat and offal from areas in the world in which the disease is endemic.

The latest research work at Pirbright is the use of unweaned mice as experimental animals in the study of these viruses. Their use will obviate to a large degree the need for using cattle in some of the work.

* Agricultural Research Council. Foot-and-Mouth Disease Research: Interim Report. Pp. iv+12. (London: H.M. Stationery Office, 1952.) 6d. net.

Foot-and-mouth disease research can be carried out successfully only in a country relatively free from the disease and under elaborate conditions of isolation. Pirbright is ideally situated for this purpose. The results fully justify the existence of the Institute, and it is encouraging to read that "a large expansion of the buildings and facilities is planned" and that "When the additional facilities are available, the staff will be strengthened and the number of animals used for experiments at one time can be increased, with a corresponding speeding up of all the investigations".

TECHNICAL AIDS IN ARCHÆOLOGY

FOLLOWING the practice adopted at Edinburgh in 1951, a session on "Technical Aids for Archæology" was organized by Section H (Anthropology and Archæology) of the British Association at the meeting this year in Belfast. Being on the opening morning of the sectional sessions, however, and held in duplicate with one on Irish archæology, attendance was disappointing.

Mr. G. F. Mitchell, Fellow and lecturer in Irish archæology at Trinity College, Dublin, spoke first on vegetational environmental studies. It is now generally accepted that the palæobotanist can be the archæologist's most valuable collaborator, giving him some chronological framework in earlier periods, and at all periods an insight into early man's environment. The classical work in this field in Denmark[1] has related the earliest appearance of plantain pollen in Neolithic levels in peaty deposits to the development of agriculture at that period, for plantain is a weed of cultivation. In Denmark also, the appearance of beech pollen at a *Grenz-horizont*, or recurrence surface, in the raised bogs demonstrates a change in climatic conditions about 500 B.C.[2], and of rye and cornflower pollens at levels formed about A.D. 1200 indicates a change in agricultural activity[3]. In Ireland also, the rise of plantain pollen demonstrates the beginning of agriculture in Neolithic times, confirmed by the grain impressions on Neolithic pottery. There is also a well-marked recurrence surface, which, though not yet precisely datable in pollen terms, may lie at about 500 B.C.[4], although there is a second, higher surface, datable perhaps to about A.D. 400.

In evaluating climatic changes the natural sequence of pollen proportions is required, and this must be sought so far as possible from man's activities at that period, for these tended to destroy the natural woodlands and, in some places, produced heaths which invaded abandoned fields. Study of the ratio of herb to tree pollen makes possible some estimate of early agricultural activity, and the shrinking of forests may be traced as more skilled methods of agriculture were developed.

The seeds, charcoals and woods associated with early human activity show that the wood of all native trees was used in some way, that blackberries, elderberries, raspberries, strawberries and hazel-nuts were collected[5], that barley, oats, wheat and flax were cultivated, and that weeds were very abundant in prehistoric fields. The stomach of a Beaker period burial in the submerged clay of the Essex coast contained a pint of seeds, mostly blackberry[6], and in that of an Iron Age corpse recently found in a Danish bog seeds of pale persicaria, white goosefoot, corn spurry and black bindweed predominated. These plants were formerly cultivated, and, as they also occur in deposits of the early centuries of the Christian era in Ireland, they may have been cultivated for food there also.

Mr. E. M. Jope, lecturer in archæology in Queen's University, Belfast, spoke next on "History, Archæology and Petrology". During the past fifteen years the value of petrological examinations, especially of stone axes, has become fully appreciated by prehistorians. A number of axe factory sites are now known in the British Isles, and the petrologically determined distribution of their products is revealing wide, and sometimes unsuspected, contacts in Neolithic times. A lead was given by the Stone Axe Sub-Committee of the South-Western Group of Museums, which has published three reports[7], and a more general view is emerging as studies appear from other areas[8]. But the petrological demonstration that the Stonehenge 'bluestones' were brought from the Presely mountains in Pembrokeshire[9] nearly four thousand years ago still remains one of the most outstanding facts of British prehistory.

The study of building materials, particularly those in medieval buildings, can illuminate the economics and organization of the building trade; and as the material is bulky, when it is shown in use at a distance from its source reasonable transport facilities are implied, in many cases by road. Some valuable studies are already available[10], but the rate of such work is usually determined by the availability of reliable petrology, without which it is valueless, and much remains to be done in this field largely ignored by architectural historians. Some materials are, however, recognizable macroscopically with small chance of error, and systematic study of some of these is now showing the possibilities of this approach. Thus, Purbeck marble was extensively used throughout the civil zone of Britain in Roman times[11] and, after a lapse of about 750 years, was again even more extensively used throughout the Middle Ages. The marble industries of the Mediterranean area in Roman times are being studied at the British School at Rome[12]. Granite began to be commonly used in Devon and Cornwall churches during the fifteenth century, particularly as monolith arcade piers weighing often as much as five tons; and in a recent survey these have been found in nearly three hundred churches, some of them twenty miles or more from the granite outcrops, requiring land transport, in some documented instances by cart. The medieval export of blue slate from Wales[13], and from Cornwall and Devon[14], has also been studied. A survey of the medieval use of fine-quality building stone from the area of Great Oolite extending up the Cotswolds from Bath to Burford is now in progress, and it is already clear that such work can supplement surviving building accounts to give a more balanced estimate of the economic importance of such a stone industry[15].

An understanding of the variety of stones used for different purposes in historic buildings is of the utmost importance as basic data for the architects and others responsible for maintenance, if the buildings are to be preserved in a condition as near as possible to the designers' and builders' intentions[16]. This aspect has, in the past, been much neglected, as many historic buildings, particularly in Oxford, bear witness.

The third paper, by Mr. L. Biek, of the Ancient Monuments Laboratory, Ministry of Works, was on "Antiquities, Ancient Monuments and Research on Materials". In it he discussed first the relation

between the scientific worker and the world's heritage of material culture[17]. A study of antiquities and ancient monuments by laboratory methods not only helps field archæologists by correlating the condition of finds with their environment, but also leads to better preservation and a fuller understanding and appreciation of objects by presenting them as nearly as possible in their original forms, as they were conceived by their makers. The benefits of such collaboration may, moreover, be mutual, for men of science working in some fields, such as corrosion studies, may gain a new insight into their own problems. Such work requires properly staffed laboratories which are specially intended for the problems involved[18].

Numerous illustrations of the results of such work, some with excellent coloured slides, were then given by Mr. Biek. Much new knowledge of early craftsmen's techniques comes from the detailed laboratory examination of their handiwork. Thus, the use of mercury in gilding sixth-century Merovingian brooches has been established, the mercury still being traceable microchemically. X-ray shadowgraphs have been invaluable in the study of antiquities, showing up even before cleaning, and without in any way altering the object, many details of their structure and decoration.

Recent studies in the Ancient Monuments Laboratory have shown that many of the rings used in making chain-mail of Roman times, found at Richborough, were punched out of cast sheet bronze. From a purely scientific point of view, the extreme fragility of similar rings, which must on internal evidence be taken to have been cold-worked, suggests that some ageing factor, as distinct from corrosion, may be operative under certain conditions. The survival on such rings of traces of suspension fibres (bast fibres, probably flax[20]) may possibly have been aided by the presence of corrosion products. But the most definite pointer of scientific interest provided by archæological finds was given by some excellently preserved iron objects of Roman and Saxon origin recently found at Hungate, York. Here research[21] showed that corrosion had been inhibited by phosphate and tannate, and the latter's suppression of sulphate-reducing bacteria was demonstrated for the first time. Such work is of potential value in the protection of present-day buried pipelines, for it has been estimated that the cost to England and Wales is £5 million a year due to corrosion losses in water mains alone.

Mr. Biek discussed the detailed collaboration of the laboratory staff with the archæologists in the field, not only on excavations but also in the study and preservation of buildings. Preservation of stonework has been much discussed in the past, and the study of masonry and brickwork in relation to their environment and the mortars used remains of greatest importance. It is also possible to learn something about early timberwork in buildings, and evidence of 'soft rot', a condition only recently recognized[22], has now been detected in the cavities left by bonding-timbers in the medieval masonry at Framlingham Castle, Suffolk. Apart from one very small piece of wood carrying this information, no trace of woody material was found in any of the several cavities, which originally contained timbers 15 ft. long by 1 ft. in diameter. In more modern buildings, the copper roof at Lancaster House and the century-old cast-iron tiles on the Houses of Parliament have recently been studied.

It is in the nature of things that references to such work should be widely scattered among many journals over a number of years, and only if there is direct systematic contact between archæologists and other scientists can the difficulties arising from such a state of affairs be reduced.

These three papers demonstrated selected aspects of collaboration between the natural sciences and archæology, and emphasized how the whole scope of inquiry into the past is being widened by this approach to the material. More laboratory facilities are required, such as are already operating at the British Museum, the Courtauld Institute, the Ministry of Works Ancient Monuments Branch, or Dr. H. Godwin's Sub-Department of Palæobotany at Cambridge, and in them workers are needed who by inclination are interested in archæological and historical problems as well as in those of the natural sciences. Neither are surely unreasonable requirements. It was encouraging to see that all three speakers at this session ranged widely in time, treating the study of material remains in both prehistoric and historic times as a continuum, and emphasizing what is generally accepted in classical studies, that in the Middle Ages, and even in more recent periods, a complete historical picture is not to be derived from written sources alone.

E. M. Jope

[1] Iversen, J., "Land Occupation in Denmark's Stone Age", *Danmarks Geologiske Undersøgelse*, 2nd ser., No. 66 (Copenhagen, 1941). Clark, J. G. D., "Prehistoric Europe", 91 (1952).

[2] Granlund, E., "De Svenska Högmossarnas Geologi", *Sveriges Geoliska Undersökung*, Ser. *C*, No. 373 (1932).

[3] *Nature*, **168**, 672 (1951). Mikkelsen, V., *Res. Botanicæ Danicæ*, **13**, No. 5 (1949).

[4] Jessen, K., *Proc. Roy. Irish Acad.*, **52** *B*, 88 (1949). Mitchell, G. F., *ibid.*, **53** *B*, 111 (1951). Hencken, H. O'N., *J. Roy. Soc. Antiq. Ireland*, **81**, 53 (1951).

[5] Bertsch, K., *Badische Fundber.*, **2**, Pt. 9 (1932). Lechler, G., "The Nutrition of Palæolithic Man", *Pap. Michigan Acad. Sci., Arts and Lett.*, **30**, 499 (1945).

[6] Warren, S. H., *Essex Naturalist*, **16**, 201 (1911).

[7] *Proc. Prehist. Soc.*, **6**, 50 (1941); **12**, 47 (1947); **17**, 99 (1951).

[8] *Proc. Prehist. Soc.*, **15**, 1 (1949); *ibid.*, **17**, 159 (1951). *Adv. Sci.*, **8**, 15 (1951). *Ulster J. Archæol.* (in the press). Brit. Assoc. Handbook, 78 (Belfast, 1952). Clark, J. G. D., "Prehistoric Europe", 243 (1952).

[9] Thomas, H. H., *Antiq. J.*, **3**, 239 (1923). Stone, J. F. S., *ibid.*, **30**, 145 (1950).

[10] Arkell, W. J., "Oxford Stone" (1947). Neaverson, E., "Medieval Castles in North Wales" (Liverpool, 1947). Wallis, F. S., *Proc. Somerset Archæol. Soc.*, **94**, 78 (1948–49).

[11] Dunning, G. C., *Archæol. Newsletter*, **1**, 15 (March 1949).

[12] *J. Roman Studies*, **41**, 89 (1951).

[13] North, F. J., "The Slates of Wales" (2nd ed.), 88 (Cardiff, 1946).

[14] *Antig. J.* (in the press).

[15] *Berkshire Archæol. J.*, **51** 58 (1948–49).

[16] Arkell, W. J., "Oxford Stone", **79**, 162 (1947).

[17] *Museum*, **5**, 45 (Unesco: Paris, 1952).

[18] *Museums J.*, **51**, 291 (1952). *Museum*, , 45 (Unesco, Paris, 1952).

[19] *Museum*, **4**, 187 (Unesco, Paris, 1951).

[20] British Cotton Industry Research Association, 1952. Unpublished report on fibre from Jutish cemetery at Buckland, Dover.

[21] Chemical Research Laboratory, D.S.I.R., 1952. An investigation of factors responsible for the preservation of iron articles on an archæological site, Farrer, T. W., Biek, L., and Wormwell, F. (in preparation).

[22] Forest Products Res. Lab., Ann. Rep., 31 (1949).

OBITUARIES

Prof. H. E. Roaf

We regret to record the death of Herbert Eldon Roaf, professor emeritus in the University of Liverpool, on September 21 at the age of seventy-one.

Roaf was a Canadian who graduated at the University of Toronto and went to Liverpool to work under the direction of Benjamin Moore as Johnston Colonial Research Fellow. This early association

with the famous biochemist is probably responsible for the interest in the chemical and physical aspects of physiology which Roaf sustained throughout his life, and which showed itself particularly in his earlier papers and in the work on biological chemistry which he published in 1921.

In 1906 Roaf was appointed assistant lecturer in the Department of Physiology under Sir Charles Sherrington, with whom he collaborated in research on the central nervous system. In 1911 he left Liverpool to become a lecturer in physiology at St. Mary's Hospital Medical School, London, and in 1920 was appointed to the chair of physiology at the London Hospital Medical College. He returned to Liverpool in 1932 as George Holt professor of physiology—a post which he held until his retirement in 1944. His chief interest in physiological research was colour vision, in which field he made many important contributions; but he was a man of wide and deep learning in his subject, and his "Text-book of Physiology" showed this clearly. He was a gentle, modest man, well loved by his colleagues and students, to whom he was devoted. During the War he undertook research on vision for the Admiralty, besides bearing a heavy burden of teaching and administrative work, in a department considerably denuded of staff.

He married Beatrice Sophie, daughter of Sir William Herdman, who survives him with two sons and two daughters.

Dr. William Brown

Dr. William Brown, founder of the Institute of Experimental Psychology in the University of Oxford, died in the early spring. Educated at Collyer's School, Horsham, at Christ Church, Oxford, and in Germany, he had a wide preparation for psychological work, having taken Mathematical Moderations, final honours in physiology, and Greats. He was John Locke Scholar in mental philosophy in 1906 and received his M.D. in 1918. In 1930 he was made a Fellow of the Royal College of Physicians. His first psychological work was done with Spearman at the University of London. This association produced what is now known as the Spearman–Brown formula, widely used in assessing the reliability of mental tests. In 1914 he was appointed reader in psychology at the University of London, which post he held until 1921. From 1921 until 1946 he was Wilde reader of mental philosophy at the University of Oxford, and during 1925–31 psychotherapist at King's College Hospital. In 1936 he became director of the Institute of Experimental Psychology at Oxford, which was founded with the assistance of a friend and patient of his.

Apart from his early work on the statistical treatment of mental measurement, which was of a high order, Dr. Brown's main achievement was, on one hand, to have brought about the recognition of experimental psychology at Oxford; on the other hand, his clinical work was unusually successful in that he obtained within the medical profession the reputation for meticulous care in excluding all physical causes before making a psychiatric diagnosis.

William Brown was very much interested in scientific societies. He was a member of the Mind Association, of the Royal Medico-Psychological Association and of the Royal Institute of Philosophy, and was president of Section J (Psychology) of the British Association for the Advancement of Science in 1927. He was president of the Society for the Study of Addiction, and associate foreign member of the Société Française de Psychologie. He had been a major in the R.A.M.C. during the First World War. Barely three months before his death, at the age of seventy-one, he delivered an astonishingly vigorous presidential address to the British Psychological Society.

NEWS and VIEWS

Nobel Prize for Physics, 1952

The Nobel Prize for Physics for 1952 has been awarded jointly to Prof. E. M. Purcell, of Harvard University, and Prof. Felix Bloch, of Stanford University, California.

Prof. E. M. Purcell

Prof. E. M. Purcell, who was born in 1912, graduated from Purdue University with a B.Sc. in 1933 and spent the succeeding year at the Technische Hochschule, Karlsruhe. In 1935 he went to Harvard, where he obtained his Ph.D., and joined the teaching staff as instructor in physics. During the Second World War he was associated with microwave work at the Massachusetts Institute of Technology. In 1945 he returned to the Lyman Laboratory of Physics at Harvard, and it was there that he made his discovery on magnetic absorption effects. Many physicists had been looking for dispersion or absorption effects of the magnetic properties of matter similar to those observed in the case of dielectrics, but it remained to Prof. Purcell to find the right conditions under which they manifest themselves. The first experiment was performed by putting a lump of paraffin wax contained in a resonant cavity into a magnetic field and observing the change of the Q-value when the magnetic field, H, passed through the resonance point ($h\nu = 2\mu H$). This absorption effect is very intimately connected with the mechanism by which the spin system transfers energy to the crystal lattice, a point which is very clearly emphasized in his first paper. The method is also of great sensitivity and has been used for measuring the proton magnetic moment of hydrogen gas. Since the first observation, many papers have been published by Prof. Purcell and others on details of great importance, such as line shapes and the use of the method for structural studies of crystals.

Prof. Felix Bloch

Prof. F. Bloch, who is professor of theoretical physics in Stanford University, was born in 1905 in Zurich, Switzerland, where he obtained his training (1924–27) in theoretical physics at the Federal Institute of Technology. He was awarded his doctor's degree in Leipzig (1928), where Prof. W. Heisenberg was pursuing his fundamental studies on quantum mechanics, and the following years were spent in Holland and in Copenhagen with Prof. Niels Bohr. In 1933 Bloch became *Privatdozent* under Heisenberg and was awarded, in the same period, a Rockefeller Fellowship which led him to Prof. E. Fermi in Rome.

During these years Bloch published papers on quantum theory, the electrical and magnetic properties of crystals, and produced his basic contribution to ferromagnetism. Also into this period falls his work on the energy losses of fast charged particles, a paper the results of which are still of great use to nuclear physicists.

When the intellectual climate in Germany became intolerable, Bloch emigrated, in 1934, to Stanford University, California, where he became associate professor of mathematical physics. He continued his theoretical studies, mostly on problems about interaction between radiation and matter and on nuclear physics, but became also interested in experimental physics. In 1940, in collaboration with Alvarez, he was the first to determine the magnetic moment of the neutron. War research at Stanford University, at the Los Alamos Laboratory and at Harvard University occupied the years 1942–45. As soon as conditions permitted, Bloch returned to Stanford, taking up theoretical and experimental research in physics. Papers on neutron polarization by ferromagnetic media and studies of the behaviour of atoms in a time-varying magnetic field followed. In 1946 Bloch published his theory, and also, in collaboration with the late W. W. Hansen and M. Packard, the experimental method, which he called nuclear induction, of measuring nuclear magnetic moments with greatest precision. The method resembles that of Rabi, of Columbia University, in so far as transitions are induced by a radio-frequency field between the sub-levels of a nucleus placed in a magnetic field. The great advantage of Bloch's method lies in the fact that one can use bulk material and pick up the induction signal with a coil. The sharpness of the resonance has permitted the attainment of a very high accuracy of the measurement of nuclear magnetic moments, and the sensitivity of the method permits the study of nuclear species available in only small quantities, such as tritium. The nuclear induction method has spread to a great many laboratories, and its use for measuring magnetic fields in terms of the proton nuclear moment is now a standard technique. Many new and unexpected features have been discovered, such as the fine structure of the proton lines in organic compounds, an observation which may well open up a new tool for organic chemists.

Principal of University College of North Staffordshire : Sir John Lennard-Jones, K.B.E., F.R.S.

It has been announced that Sir John Lennard-Jones, Plummer professor of theoretical chemistry in the University of Cambridge, has been appointed principal of the University College of North Staffordshire, in succession to the late Lord Lindsay of Birker, formerly Master of Balliol College, Oxford, who was principal from the foundation of the College in 1950 until his death in March this year. Born in 1894, Sir John studied in the University of Manchester and Trinity College, Cambridge. During the First World War he was first a pilot in the Royal Flying Corps and then an experimental officer in the Armament Experimental Station at Orfordness. His first academic post was as a lecturer in mathematics in the University of Manchester, and then he moved to the University of Bristol as reader, and later professor, of mathematical physics. Since 1932 he has been Plummer professor of theoretical chemistry in Cambridge. During the Second World War he served in a scientific capacity in the Ministry of Supply, being for three years chief superintendent of armament research and later director-general of scientific research (defence). Since 1947 he has been chairman of the Scientific Advisory Council of the Ministry. He has been president of the Faraday Society, and is now a member of the Scientific Advisory Committee of the National Gallery. Sir John, who is distinguished for his work in various branches of theoretical physics and chemistry, particularly the electronic structure of molecules, was elected to the Royal Society in 1933 and was made K.B.E. in 1946. He thus takes to his new post in North Staffordshire a wide experience of universities, scientific research and administration.

The Imperial Institute : Sir Harry Lindsay, K.C.I.E., C.B.E.

Sir Harry Lindsay retires at the end of January 1953 from the Imperial Institute, where he has held the post of director with great distinction since he succeeded Sir William Furse in 1934. The major qualification for this post is a living and working knowledge of the British Commonwealth overseas. Prior to his appointment, Sir Harry had been a member of the Indian Civil Service, serving in India during 1905–22 and finally as Indian Trade Commissioner in London until 1934. Incidentally, his father, grandfather and great-grandfather had all served in India in various capacities, both civil and military. Recognizing that the scientific side of the Imperial Institute was in good hands, Sir Harry devoted his main attention to improving the exhibition galleries and publicizing by lectures the importance of the Commonwealth countries, both the Dominion and the Colonies. He himself has given many of these lectures, and his personal experience, gained by visits to South Africa during 1936–37 on the occasion of the Empire Exhibition and on a lecture tour of Canada in 1938, made them particularly valuable. The development of the Imperial Institute Galleries has always been handicapped by lack of funds ; but Sir Harry has managed to obtain much support from many of the Dominions and Colonies and also from industrial firms. As a result the galleries have been enriched by a valuable series of dioramas studied with pleasure and profit by the parties from schools which regularly visit them. During recent years, Sir Harry has maintained an active interest in the work of societies which have strong Commonwealth and educational ties. He was chairman of the Council of the Royal Society of Arts during 1947–49 and edited the "British Commonwealth Objectives" for the Society. He was president of the Royal Geographical Society during 1948–51, of the Geographical Association in 1949 and of Aslib in 1940, and for many years served on the Councils of the Royal Empire and Royal India, Pakistan and Ceylon Societies.

Mr. Kenneth Bradley, C.M.G.

Mr. Kenneth Bradley, who succeeds Sir Harry Lindsay on February 1, has had wide and varied experience in the Colonial Empire. He served in Northern Rhodesia as an administrative officer during 1926–39 and then as information officer until 1942. He laid the foundations of the present department, including the inauguration and development of a broadcasting service to the African population. In 1942 he went as Colonial Secretary and Financial Secretary to the Falkland Islands and, while there,

took part in the establishment of bases for the Falkland Islands Dependencies Survey in the Antarctic. He received the C.M.G. in 1946 and early in that year was promoted to the post of Under-Secretary in the Gold Coast. He served there, acting as Colonial Secretary for most of the time, until 1948. In 1947 he was chairman of the Gold Coast Committee which recommended the establishment of the present Gold Coast University College. In the following year he retired from the Colonial Service in order to become the first editor of *Corona*, the professional journal of the Colonial Service. Mr. Bradley has, since he came to London, particularly interested himself in the task of spreading knowledge about the Commonwealth and has given many broadcasts and lectures and contributed widely to periodicals in Britain and throughout the Commonwealth. He is a recognized authority on African affairs. He has published several books on African subjects, of which the two best known are "The Diary of a District Officer" (Harrap, 1942; Nelsons, 1948) and "The Colonial Service as a Career" (H.M.S.O., 1950), and has in the press a history of the Roan Antelope and Mufulira copper mines and of the early development of Northern Rhodesia as a whole under the title "Copper Venture".

The Oxford Synchrotron

THE Oxford 140-MeV. synchrotron has recently been undergoing preliminary trials at 60 MeV. This machine was built with funds supplied by the Department of Scientific and Industrial Research. During the past year much trouble has been encountered owing to the charging-up of the orbit tube wall, but these difficulties are now being overcome. The X-ray yield so far obtained is moderate, a thin copper target irradiated to saturation at a metre from the target showing a copper-62 activity of about 10,000 counts per min. per gm.

Science in the University of Glasgow

FOR the present session there have been 225 new admissions to the Science Departments of the University of Glasgow, compared with 232 a year ago. There are about 179 research students. In all sections of the University the total number of matriculated students is now about 5,820. A new feature of the teaching of bacteriology in the University (under Prof. J. W. Howie as its Gardiner professor) is that it now ranks as a science subject for degree courses. It may be taken either as a single or double qualifying course for the ordinary degree, or as a principal subject of an honours curriculum, which includes courses in botany, zoology, chemistry and biochemistry. There is also a combined honours curriculum in bacteriology and biochemistry.

The following appointments have recently been made in the University: Dr. F. E. Moon has been appointed senior lecturer in agricultural chemistry; Imperial Chemical Industries Fellowships have been awarded to Drs. M. F. Grundon and H. J. E. Loewenthal (for work in the Chemistry Department on curare and in the polycyclic field, respectively) and to F. C. Flack (gamma-ray spectroscopy in connexion with the high-tension set in the Natural Philosophy Department).

Synthesis of Vitamin B_{12} by *Rhizobium meliloti*

IT has been shown by M. O. Burton and A. G. Lockhead (*Canad. J. Bot.*, 30, 5, 521; 1952) that, of seventy strains of six species of *Rhizobium*, *R. meliloti* is sharply distinguished from the others by its ability to synthesize significantly larger quantities of vitamin B_{12}, one strain producing 1,000 mμ gm. per ml. of liquid culture medium. No correlation was observed between the vitamin-synthesizing capacity of individual strains and their effectiveness in nitrogen fixation.

Bristol Museum

THE annual report for 1951 of the City Museum, Bristol, is a good example of how provincial institutions accepted the challenge presented to them by the Festival of Britain. In Bristol it was decided to stage an exhibition portraying to some extent the topography and natural history of the city in 1851. One part of the large gallery was arranged realistically with lay figures and furniture to simulate the essential features of a drawing room. In addition, material and lay figures showed a hatter's and a sailmaker's workshop, while side panels depicted aspects of the railways, shipping, natural history and geology of the Bristol area in 1851. The report also describes new developments at the Museum during 1951, chief of which was the opening of a room specially for children making use of the Museum's service to schools. In addition, seventeen temporary exhibits were arranged as well as a series of winter lectures and conducted summer walks.

Proceedings of the Glasgow Mathematical Association

DURING the past fifty years the numbers of those engaged in research in pure mathematics has increased many times; but there has been no corresponding increase in the number of British journals available for the publication of their work. We therefore heartily welcome the appearance of a new journal, entitled *Proceedings of the Glasgow Mathematical Association*, but actually containing papers not only from Glasgow but also from England, Canada and South Africa. Manuscripts from all parts of the world are invited, primarily, but not exclusively, on pure mathematics, and should be sent to the Editor, Glasgow Mathematical Association, Department of Mathematics, University, Glasgow, W.2. The *Proceedings* will be published each January and July, the first part having appeared in January 1952. Four parts will make up a volume of about two hundred pages. The prepaid subscription for each volume is £2 (or 6 dollars) post free, and single parts may be obtained for 10*s*. 6*d*., from the publishers (Edinburgh and London: Oliver and Boyd, Ltd.) or from any bookseller.

Plant Breeding Institute, Cambridge

THE Plant Breeding Institute at Cambridge, for many years part of the School of Agriculture, University of Cambridge, which was responsible for its administration with the aid of grants from the Ministry of Agriculture and Fisheries, has now been constituted as an independent research institute. It will continue to be financed by grant-aid from the Ministry and to come under the scientific supervision of the Agricultural Research Council. The Institute now takes the form of a company limited by guarantee, and without share capital. The membership of the governing body is as follows: Sir Frank Engledow (chairman); Prof. G. E. Briggs; Prof. W. Brown; Mr. E. Cave; Prof. S. C. Harland; Prof. H. Ian Moore; Prof. J. W. Munro; Prof. T. G. B. Osborn; Mr. R. W. Ward.

Earthquake near Kamchatka

On November 4 at 16h. 58m. 20s. G.M.T., an earthquake occurred with epicentre, according to calculations made at the U.S. Coast and Geodetic Survey in Washington, at lat. 52½° N., long. 159° E., near the east coast of Kamchatka. It was recorded strongly at seismological observatories throughout the world and had a magnitude of 8¼ on the Gutenberg–Richter logarithmic scale. This is a smaller magnitude than that of the great Sikang–Assam earthquake of August 15, 1950; but had the Kamchatka earthquake happened on land it would undoubtedly have occasioned great damage. Faulting probably took place in the sea bed near the epicentre, since a great tsunami or seismic sea wave resulted, and spread throughout the Pacific Ocean. It arrived at the coast of northern Japan about 20h. G.M.T. on November 4. The Hawaiian warning system was used, and the coastlands of several islands, including the Oahu coast, were evacuated in anticipation of the wave. When the wave arrived at Hawaii itself, it is reported to have been several feet high, and would have caused much damage had not precautions been taken. Waves from one to three feet high arrived at the Whangarei beaches in the north of New Zealand about 7 p.m. local time on November 5. When these waves arrived at Wellington, they were 6–8 in. high. No news has yet been received from the nearest town to the epicentre—Petropavlovsk on the Kamchatka Peninsula—nor from the International Seismological Association central station at Strasbourg. Immediately following the main shock, there were more than a hundred aftershocks. Further news is awaited.

Provisional readings, all in G.M.T., of seismograms at Pasadena were: *eP*, 17h. 08m. 23s.; *iP*, 17h. 08m. 37s.; *e*(*PP*), 17h. 11m. 0s.; *eS*, 17h. 16m. 39s.; *iS*, 17h. 16m. 48s.; *i*(*ScS*), 17h. 18m. 11s.; *eG*, 17h. 23·2m.; *iG*2, 19h. 22m.; max. *H*, 2,000 ± *μ*; and at Stuttgart: *iP*, 17h. 10m. 12·0s. compression; *i*, 17h. 10m. 14·6s. compression; *i* !, 17h. 10m. 21·0s. compression; *i* ! (*PcP*), 17h. 10m. 24·0s. dilatation; *iPP*, 17h. 13m. 20s.; *iS*, 17h. 20m. 10s.; *eG*, 17h. 31m. (*T* = 80 sec. !); *MQ*, 17h. 40m.; *MR*, 17h. 41–42m. (*Z* = 5,400 *μ*); *MR*, 17h. 50m.

The Night Sky in December

Full moon occurs on Dec. 1d. 12h. 41m., U.T., and new moon on Dec. 17d. 02h. 02m. The following conjunctions with the moon take place: Dec. 12d. 20h., Saturn 8° N.; Dec. 15d. 14h., Mercury 7° N.; Dec. 20d. 08h., Venus 2° S.; Dec. 21d. 02h., Mars 2° S.; Dec. 26d. 20h., Jupiter 7° S. Mercury is too close to the sun at the beginning of December for favourable observation, but at the middle and end of the month its times of rising are 6h. 05m. and 6h. 50m., respectively, and it can be seen for a short time before sunrise; owing to its large southern declination, it will not rise far above the horizon. Venus is an evening star, setting at 18h. 25m., 19h. 05m. and 19h. 50m. on December 1, 15 and 31, respectively. The visible portion of the illuminated disk varies from 0·75 to 0·65, and the stellar magnitude averages − 3·7. Mars, an evening star, sets at about 20h. 20m. throughout the month, stellar magnitude about 1·1. It is easily recognized during the middle of December close to *γ* and *δ* Capricorni. Jupiter is visible throughout the night, setting in the morning hours at 5h. 15m., 4h. 15m. and 3h. 10m. on December 1, 15 and 31 respectively, stellar magnitude about − 2·3. Saturn, a morning star, rises at 3h. 25m., 2h. 40m. and 1h. 40m. at the beginning, middle and end of the month, respectively, stellar magnitude 0·9, and is visible for some hours before sunrise in the constellation of Virgo. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Dec. 4d. 1h. 55m., 37 Gemi. (*R*); Dec. 6d. 5h. 11·7m., *δ* Canc. (*D*); Dec. 6d. 6h. 15·9m., *δ* Canc. (*R*); Dec. 28d. 1h. 24·3m., 16 Taur. (*D*); Dec. 28d. 1h. 31·4m., *q* Taur. (*D*); Dec. 28d. 1h. 50·7m., 20 Taur. (*D*); Dec. 28d. 1h. 53·7m., 21 Taur. (*D*). *R* and *D* refer to reappearance and disappearance, respectively. Winter solstice takes place on Dec. 21d. 22h. Observation of the Geminid meteors during the first week in December will be difficult owing to moonlight.

Announcements

The conference this year of the Universities of Great Britain and Northern Ireland, convened by the Committee of Vice-Chancellors and Principals, will be held in the Senate House of the University of London during December 12–13. There will be three sessions on the following subjects: halls of residence and student amenities; success and failure at the university; and vacation employment. The Conference is only open to delegations appointed by the universities and to specially invited guests. Further details can be obtained from the secretary of the Committee, J. F. Foster, at 5 Gordon Square, London, W.C.1.

On the occasion of the twenty-second annual general meeting of the Printing, Packaging and Allied Trades Research Association, an exhibition of the Association's work will be held at the Connaught Rooms, Great Queen Street, London, W.C.2, on December 4. The displays will illustrate the work carried out in the Association's laboratories on the chemistry and physics of printing inks, papers, the testing of packages and containers, bookbinding, and the protection of packages against insect attack. New apparatus and new wash-up solvents will be shown, and the manner in which the Association endeavours to place its findings before its members will be illustrated. Further details can be obtained from the Association at Patra House, Randalls Road, Leatherhead, Surrey.

The National Science Foundation and the University of Rochester are sponsoring a conference on high-energy nuclear physics to be held in Rochester, N.Y., during December 18–20. The conference will be financed by a 2,000-dollar grant from the Foundation and contributions from several industrial firms in Rochester. The conference will bring together about seventy nuclear physicists from the United States, Canada and Mexico to discuss recent research findings on high-energy particles and to plan future studies in this field. Further information can be obtained from the National Science Foundation, 2144 California Street, N.W., Washington 25, D.C., or from the Department of Physics, University, Rochester, N.Y.

In the April and May issues of *L'Astronomie* there are two accounts of the eclipse of the sun at Khartoum on February 25, with a number of photographs taken by J. Leclerc and E. Geneslay. The first account is by several authors, and the second by L. D'Azambuja, of the Paris-Meudon Observatory. These detailed descriptions will prove very helpful to everyone interested in solar eclipses.

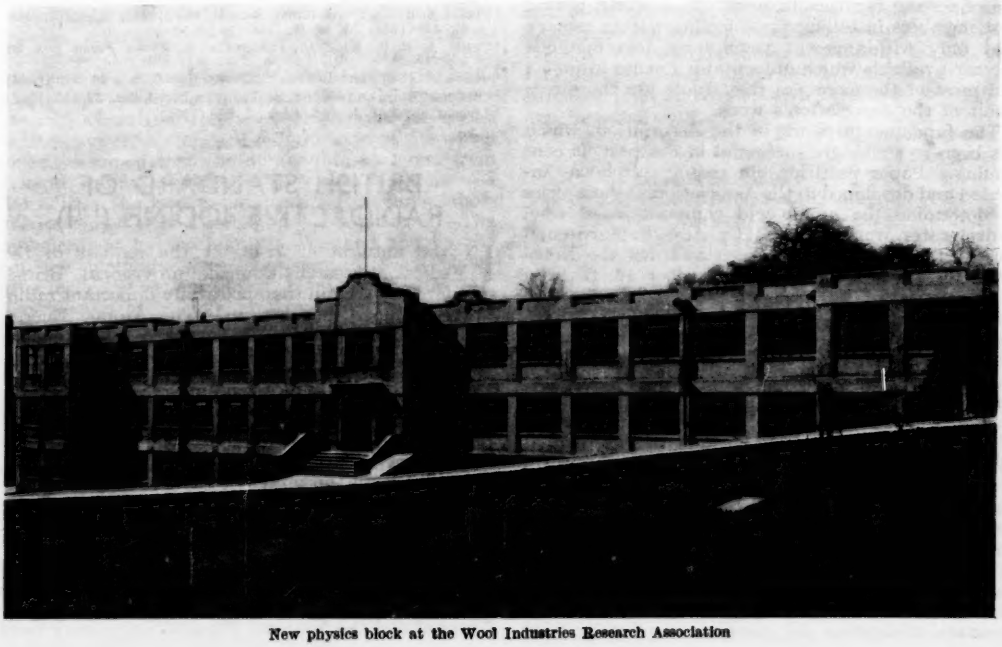
WOOL INDUSTRIES RESEARCH ASSOCIATION

EXTENSION TO LABORATORIES

POST-WAR extensions of the laboratories at Torridon, Leeds, of the Wool Industries Research Association were opened on October 17 by Viscount Swinton, Chancellor of the Duchy of Lancaster and Minister of Materials. The nucleus of the Research Association was formed in 1915 when a 'West Riding Research Committee' of interested industrialists, under the guidance of the late Sir Michael Sadler, vice-chancellor of the University of Leeds, initiated co-operative research which was financed by the local industry. This Committee was able to take full advantage of the Research Association scheme which was put forward by the Department of Scientific and Industrial Research in 1918. Indeed, the Wool Industries Research Association was the second to be formed under the ægis of the Department. The work of the Research Association was originally undertaken at the University of Leeds; but the need for separate laboratories soon became apparent, and in 1920 Torridon, a large residence standing in about four acres of ground, was purchased, and this provided reasonable accommodation for a limited number of laboratories and offices. In 1925 a shed was erected for woollen plant and later another was added for worsted plant, and in 1928 the adjoining estate of Longfield was purchased with a capital grant from the Empire Marketing Board. A new block was built for wet processing in 1939, and looms were installed in some of the original outbuildings.

In 1947 a progressive building plan was started. The wet-finishing block was extended to provide laboratory accommodation together with more extensive facilities for pilot-scale dyeing. This and three large new blocks have now been completed. The first contains pure and applied physics laboratories, including two large physical-testing laboratories where the atmosphere is controlled to 65 per cent relative humidity and 68° F. (20° C.), a drawing office and machine shop. As fibre properties are so sensitive to atmosphere changes, the whole of the block, other than the testing laboratories, is supplied with air maintained at 50 per cent relative humidity and 65° F., except when these conditions require the use of refrigeration. The second block to be finished houses woollen-carding and -spinning machinery, together with a raw-wool scouring plant in the basement. This block is also fitted with humidifying plant. The third block is for research on weaving and is equipped with a full range of preparatory machinery in addition to looms and with laboratory facilities. One room is humidified so that weaving can be done under a range of atmospheric conditions. The new buildings provide roughly sixty thousand square feet of floor area and with their equipment have cost about £250,000.

Research in the past has tended to be fundamental rather than applied, due largely to the big floor areas needed to house processing equipment. The new buildings were designed primarily to overcome this difficulty, and it should now be possible to undertake much more extensive research in fields that lead directly to increased industrial efficiency. As Lord Swinton said in his opening speech: "Research is the eyes of industry, and corporate research, industry combining for research, is the best of all; here in the Wool Industries Research Association you are, I think, a model because it is in very truth a partnership enterprise of a multitude of firms large and small. And those combined operations in the common interest have proved in this industry, as indeed in



New physics block at the Wool Industries Research Association

others, to be no bar to individual initiative and competition." The new buildings are visible evidence of confidence in the success of corporate research because co-operation from all member firms will be essential if these facilities are to play their full part in promoting progress within the industry.

Wool is a most versatile fibre; there are in reality four wool industries—woollen, worsted, pressed felt and mechanical cloth, and the shoddy industry. The facilities now available provide for research ranging from the biology of wool growth to the finishing of fabrics, and although it is impossible to have even one example of every type of machine used in each of these separate industries, the methods and processes that are common to most of them can be fully investigated.

Perhaps the biggest expansion has been on the weaving side. Hitherto, facilities for work in this field have been negligible; but it is now possible to follow every process in preparing yarns for the loom and in weaving them on any of a representative range of looms. This is almost a virgin field for research so far as wool is concerned, and one that is likely to lead to fruitful results because much of the appearance of a finished wool fabric depends on the care with which the yarn is handled and wound between spinning and weaving.

Another aspect of the Association's work which has been increased and will benefit further from the extensions is operational research. The Association has undertaken this work in a small way for very many years, and as far back as 1947 it published to members a booklet on quality control in worsted spinning. The surveys now being made in mills, together with appropriate laboratory and pilot-plant work, provide information to members on the limits that can and should be worked to if optimum productivity and high-quality output are to be maintained with a proper economy in the use of consumable materials. The success of this work is shown by the increase in use of testing facilities in mills. It is worth noting that members installing these facilities often remark that only within recent years have test methods become available which are suitable for use in mills; and most of the examples they quote are the direct result of the Association's work.

The fundamental work of the Association, which has been so strikingly successful in the past, is continuing. Paper partition chromatography[1] was invented and developed in the Association's laboratories to determine the amino-acid composition of wool hydrolysates, work for which Dr. A. J. P. Martin and Dr. R. L. M. Synge have been awarded the Nobel Prize for 1952 (see *Nature*, November 15, p. 826). It continues to be used in the laboratories and has been improved in a number of respects, particularly with regard to the use of radioactive tracers to give a quantitative rather than a qualitative result[2]. Radioactive tracers are also in use to follow the diffusion of ions in keratin membranes, work which aims at elucidating the mechanism of dyeing. It has already yielded the result that hydrogen ions diffuse more slowly than those of bromine at low concentrations of hydrogen bromide[3]. This result is consistent with measured membrane potentials which previously seemed to be anomalous, and it can be quite simply explained on the theories of multimolecular adsorption and diffusion which have been developed for polymers at Torridon[4]. The earlier work of the Association on the importance of moisture absorption for clothing comfort and on the propagation of temperature and humidity changes through masses of textile materials[5] is now universally accepted and used throughout the world, as are the theory of water repellency of porous structures[6] and the theory of the effect of salts on ionic detergents[7].

A subject more recently studied, which has both practical and theoretical importance, is the dissipation of static electricity on fibres or polymer sheets. A solution has been found for the distribution of charge and the distribution of electric field in such systems, and the distribution of the field shows that conductivity in a liquid coating is much more effective in dissipating static charges than is conductivity of the fibre or sheet. Another subject of academic and practical interest is the friction between fibres or polymeric surfaces. Recent work has shown that, in contrast to the behaviour of metals, elastic rather than plastic deformation determines the frictional force; recognition of this difference between the two processes has explained many apparently anomalous features in the behaviour of polymeric materials during rubbing[8]. Thus, although the Association has planned for a large extension of work in the applied field, it has not lost sight of the need for fundamental research which so often inspires new ways of looking at practical problems, leading to their successful solution.

Finally, it might be mentioned that the Association's shrink-resisting process has been used by the Ministry of Supply since 1940 for Service socks and underwear. The Association has received £25,000 in royalties, and the increased life of the garments so treated has provided a saving to the Ministry of at least £5 million, which is several times the total expenditure of the Association since it was formed in 1918.

[1] Martin, A. J. P., and Synge, R. L. M., *Biochem. J.*, **35**, 1358 (1941). Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **38**, 224 (1944).
[2] Blackburn, S., and Robson, A., *Chem. and Indust.*, 614 (1950).
[3] Wright, M. L., *Trans. Farad. Soc.* (in the press).
[4] Cassie, A. B. D., *Trans. Farad. Soc.*, **41**, 458 (1945). King, G., *ibid.*, **41**, 479 (1945); King, G., *ibid.* (in the press).
[5] Cassie, A. B. D., King, G., and Baxter, S., *Trans. Farad. Soc.*, **36**, 445 (1940).
[6] Cassie, A. B. D., and Baxter, S., *Trans. Farad. Soc.*, **40**, 546 (1944).
[7] Cassie, A. B. D., and Palmer, R. C., *Trans. Farad. Soc.*, **37**, 156 (1941).
[8] Lincoln, B., *Brit. J. App. Phys.*, **3**, 260 (1952).

BRITISH STANDARD OF RADIOACTIVE IODINE (^{131}I)

In the autumn of 1948, at the request of the Medical Research Council, provisional British standards of certain therapeutically important radioactive isotopes were set up. The Atomic Energy Research Establishment[1] undertook the maintenance of standards of cobalt-60, sodium-24, and phosphorus-32; the maintenance of the iodine-131 standard was undertaken by the Radiotherapeutic Research Unit of the Medical Research Council at Hammersmith[2]. It was intended that these standards should serve for one year; their use has, in fact, continued until the present time.

Following an agreement between various interested bodies in 1950 that the National Physical Laboratory should be formally responsible for standards of this kind in Great Britain, workers from the Radiotherapeutic Research Unit, the Atomic Energy Research Establishment, the Royal Cancer Hospital and the National Physical Laboratory have

met regularly to discuss standardization and to compare measurements on a number of isotopes. As a result of the improvements in standardizing techniques and of the more precise information now available about the iodine-131 disintegration scheme, it has been agreed that a revision of the 1948 standard for the substance is necessary.

In general, an isotope emitting β- and γ-rays may be standardized by counting methods which measure almost directly the number of nuclei disintegrating per second, that is, the number of curies present. An alternative method is the measurement of the γ-ray ionization in air under conditions which permit the result to be expressed in röntgens per hour at 1 cm. from a sample of radioactive material; which result can be converted to curies per gram of the sample by means of a factor (r./hr. at 1 cm. from 1 mC.) deduced from a knowledge of the disintegration scheme, of the γ-ray absorption coefficients in air, and of the energy required to produce an ion pair in air. The 1948 standard of iodine-131 was based on this latter procedure, which gave a conversion factor of 2·54 r./hr. at 1 cm. from 1 mC. of the isotope. Using subsequent information[2] about the disintegration scheme, and assuming that the energy required to produce an ion pair in air is 32·5 eV., the factor is deduced to be between 2·27 and 2·29 r./hr. These, and all other values of this factor quoted, exclude the small contribution due to X-rays arising from internal conversion and to bremsstrahlung which is of the order of 1 per cent of the total. (Experimentally, virtually complete elimination of the X-rays and bremsstrahlung can be achieved by absorption in 0·5 gm./cm.² of copper.)

Recently, samples of iodine-131 have been distributed among the above-mentioned laboratories for measurements by counter methods, which include the defined solid-angle method using end-window β-counters, the 4π solid-angle Geiger–Müller counter, the 4π liquid scintillation counter and the β–γ coincidence method. The results by different laboratories, different counter techniques and different equipment varied by ± 5 per cent. The samples were also measured by three of the laboratories using the γ-ray ionization method. For this purpose, graphite chambers were used which were calibrated with γ-rays from standard radium sources, for which it was assumed that the dosage-rate at 1 cm. from 1 mgm. radium screened by 0·5 mm. platinum was 8·3 r./hr. The results obtained by the three laboratories varied over a range of ± 2·5 per cent. The measurement by the ionization method and by the counter methods were consistent with a value 2·25 r./hr. at 1 cm. from 1 mC. of iodine-131. Accordingly, it is now proposed that a figure of 2·25 r./hr. for the dosage-rate at 1 cm. from 1 mC. of iodine-131 (excluding the contribution due to X-rays and bremsstrahlung) should be adopted as the new standard. This differs from the previous standard in that a quantity of iodine-131 hitherto estimated as 1 mC. will now be 1·13 mC. The maintenance of the standard will be undertaken by the National Physical Laboratory; measurements will be made in terms of γ-ray ionization in graphite chambers, calibrated against a standard radium source (and using the conversion factor of 8·3 r./hr. already quoted), because of the greater convenience of this type of measurement compared with the direct counting methods. It is believed that values based on the new standard will not differ by more than ± 5 per cent from the true values.

A more detailed account is being prepared of the intercomparisons on which this new figure is based.

The mean energy emitted by iodine-131 in the form of β-rays and internal conversion electrons has been re-determined by the Radiotherapeutic Research Unit, using the lined-chamber method[2]. The value based on the new standard is 0·197 MeV. Taking into account all sources of error, this value is regarded as correct within 5 per cent.

E. C. Bullard
(Director).

National Physical Laboratory,
Teddington, Middlesex.

[1] Putman, J. L., *Brit. J. Radiol.*, **23**, 46 (1950).
[2] Gray, L. H., *Brit. J. Radiol.*, **22**, 677 (1949).
[3] Cavanagh, P. E., *Phil. Mag.*, **43**, 221, 648 (1952). Ketelle, B. H., Zeldes, H., Brosi, A. R., and Dandl, R. A., *Phys. Rev.*, **84**, 585 (1951). Verster, N. F., Nijgh, C. J., van Lieshout, R., and Bakker, C. J., *Physica*, **17**, 637 (1951). Bell, R. E., and Graham, R. L., *Phys. Rev.*, **86**, 212 (1952).

Following the review described above of the British standard of activity for the radioisotope iodine-131, the new standard will be used for dispensing this substance supplied by the Atomic Energy Research Establishment, Harwell, as from January 1, 1953. The provisional Medical Research Council standard, set up by Gray, which has been used for the assay of all consignments supplied by the Establishment from the beginning of 1949 until the present time, will be used for supplies dispensed up to midnight on December 31, 1952.

It should be noted that, whereas 1 mC. of iodine-131 measured by the provisional standard (1949) emits gamma-radiation at the rate of 2·54 r./hr. at 1 cm., 1 mC. of iodine-131 by the new standard gives 2·25 r./hr. at 1 cm. A factor of 1·13 therefore exists between the two standards, and the new standard millicurie will contain less activity than the old one.

No official intercomparison of standards for iodine-131 has yet been made between Great Britain and other countries. However, a series of unofficial measurements, relating standards from Chalk River, Canada, National Bureau of Standards, U.S.A., and Oak Ridge, U.S.A., indicate that the new British standard is in agreement with these, at least within experimental error.

Henry Seligman
John L. Putman

Isotope Division,
Atomic Energy Research Establishment,
Harwell,
Didcot, Berks.

STRUCTURAL FEATURES OF ANTITUMORIGENIC CORTICOIDS

By Drs. Elvira Mardones, R. Iglesias, F. Fuenzalida, S. Bruzzone and Prof. A. Lipschutz

Department of Experimental Medicine, National Health Service of Chile, Santiago

The antifibromatogenic action of steroids is not related to any other known physiological action of the latter; it is an independent faculty[1,2]. Thus it seems likely that 'screening' of antitumorigenic steroids may be based, tentatively, on the assumption that the antitumorigenic potency is concomitant with certain structural features of these compounds.

Progress has recently been achieved on these lines in our work on the antifibromatogenic potency of various corticoids in castrated female guinea pigs receiving, during a period of three months, œstradiol as absorbed from a subcutaneously implanted tablet.

Control experiments with œstradiol alone. Of twenty-three animals with an absorption of 16–70 μgm. of œstradiol a day, nineteen had abdominal fibroids (fibrous tumoral effect = 3·9). (This control series is not identical with that of our earlier paper[1]. Any series in which the antifibromatogenic potency of steroids is tested is always accompanied by a new control series.)

Deoxycorticosterone (acet.; m.p. 159). Deoxycorticosterone has long been known as one of the most potent antifibromatogenic steroids, being inferior only to progesterone[2,4]. In a new series of experiments, prevention of abdominal fibroids was again obtained in all the eight animals in which 135–200 μgm. of deoxycorticosterone acetate per day was absorbed from one tablet (2·9 ± 0·1 μgm. per 1 sq. mm.) subcutaneously implanted. Only fibrous strands and some tiny nodules on the spleen were present (fib. tum. effect = 1·4). In a group of four animals with an absorption of 97–118 μgm. of deoxycorticosterone acetate per day from half a tablet, the average fibrous effect was still considerably diminished (= 2·5).

17-Hydroxy-deoxycorticosterone (Reichstein's compound *S* acetate; m.p. 233)[5]. This substance differs from deoxycorticosterone solely by OH−−C_{17}. In a group of ten animals, absorption from one to three tablets was as much as 150–750 μgm. per day (2·9 ± 0·14 μgm. per 1 sq. mm.). All animals had abdominal fibroids (fib. tum. effect = 5·8).

One may infer from these results that the antifibromatogenic potency of deoxycorticosterone is considerably diminished by the substitution OH−−C_{17}.

Dehydrocorticosterone (Kendall's compound *A*, acet.; m.p. 176°). This differs from deoxycorticosterone solely by O=C_{11}. In earlier experiments of shorter duration (two months only), it was found to be antifibromatogenic, though probably less than deoxycorticosterone[6]. In a new series of nineteen animals, this was corroborated, though the difference between deoxycorticosterone and compound *A* was found to be more considerable than in former experiments. Fibromatogenesis was greatly diminished (fib. tum. effect = 1·7) by about 356–417 μgm. of *A* acetate per day absorbed from half a tablet (7·2 ± 0·4 μgm. per 1 sq. mm.; this rapid absorption makes it necessary to implant a new tablet six weeks later); but there were fibroids with a dose of 90–110 μgm. of *A* acetate per day (fib. tum. effect = 4·9; 1–3 tablets containing but 40 per cent of *A* acetate and 60 per cent of cholesterol, permitting non-selective absorption[7,8]; figures not exact on account of the breaking up of the tablets).

The above results show that the antifibromatogenic potency decreases due to O=C_{11}, though in a much less pronounced degree than with OH−−C_{17}. Cortisone is of considerable interest here, because it differs from deoxycorticosterone by both these substitutions.

Cortisone, or 17-hydroxy-dehydrocorticosterone (*E* acetate; m.p. 237°). In former experiments, abdominal fibroids were not prevented with 138 μgm. of *E* acetate per day absorbed from subcutaneously implanted tablets[9,10]. In a new group of three animals, there was again no prevention with 125–225 μgm. of *E* acetate per day (fib. tum. effect = 3·9; 6 8 tablets containing 40 per cent of cortisone and 60 per cent of cholesterol; absorption figures not exact). In a group of ten animals, as much as 457–1,050 μgm. per day were absorbed from 1–2 tablets (6·5 ± 0·14 μgm. per 1 sq. mm.; a new implantation was made six weeks later). Some prevention took place (fib. tum. effect = 2·3); but there were fibroids even with as much as 1,000 μgm. per day (2 tablets).

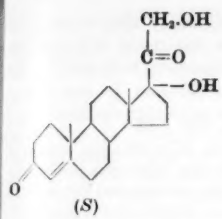
The difference between the antifibromatogenic potency of cortisone and deoxycorticosterone is very striking. But cortisone is also much less active than compound *A*. These findings are in full agreement with the statement that antifibromatogenic potency is diminished by OH−−C_{17}. However, contrary to expectation, cortisone was seemingly somewhat more potent than compound *S*, with which it shares OH−−C_{17}. That is to say, O=C_{11}, which by itself certainly diminishes the antifibromatogenic potency (*A* is less potent than deoxycorticosterone), appeared to counteract, or to reduce, the negative influence of OH−−C_{17} when simultaneously present with the latter. In view of very considerable variations as to the fibrous tumoral effect in a group of animals, it would seem wise not to attribute too much importance to the difference between compound *S* and cortisone. However, the unexpected phenomenon of reduced negative effect was shown in an even more striking way when compound *S* (17-hydroxy-deoxycorticosterone) was compared to compound *F* (17-hydroxy-corticosterone).

17-Hydroxy-corticosterone (compound *F*, acetate; m.p. 218°). In two animals, 160–235 μgm. of *F* acetate per day were absorbed from one tablet (a new implantation six weeks later); in three animals 467–518 μgm. per day were absorbed from two tablets (2·6 ± 0·4 μgm. per 1 sq. mm.). There were no fibroids, only fibrous strands and small nodules being present (fib. tum. effect = 1·2). On the contrary, in five animals with 67–95 μgm. per day absorbed from ten tablets containing 40 per cent of *F* acetate and 60 per cent cholesterol, there was no prevention of fibroids (fib. tum. effect = 3·6).

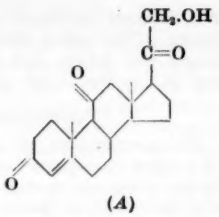
It would thus seem that, thanks to OH−C_{11}, compound *F* diverges as to antifibromatogenic potency from compound *S* and approaches deoxycorticosterone.

Suppression of the negative influence of a substitution by another one can be paralleled by older observations of ours. Whereas progesterone is the most potent antifibromatogen, pregnanedione and allo-pregnanedione, in which Δ^4 is lacking, are not antifibromatogenic[7]. On the other hand, dihydrotestosterone and methyl-dihydrotestosterone are as potent as testosterone and methyl-testosterone, or are more potent than these[11,12]. One may speculate that the interference of Δ^4 is no longer necessary when the side-chain of two carbons in C_{17} is eliminated or reduced to CH_3. (The OH in C_{17} in these antifibromatogenic androgens is in the beta position; on the contrary, the isomer of testosterone with OH−−C_{17} (formerly called cistestosterone) is not antifibromatogenic[10]. This is in full agreement with the above findings with compound *S*.)

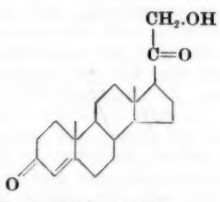
Our finding of a difference in antifibromatogenic potency between compounds *E* and *F* can be compared also to the statement that the latter is thirty times more active than compound *E* in inhibiting the growth of the chicken embryo and a hundred times more active than compound *E* in inhibiting the growth of the newly hatched chick[13]. The fact that such considerable functional differences exist



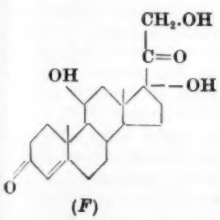
(*S*)



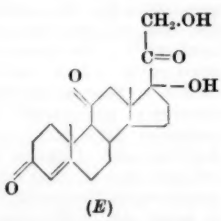
(*A*)



Deoxycorticosterone



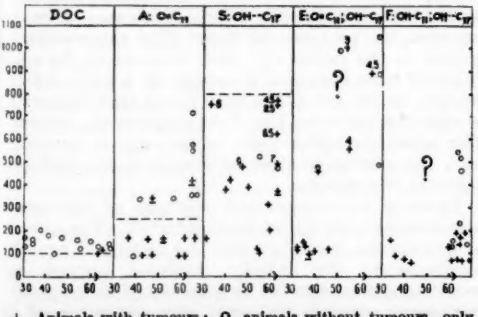
(*F*)



(*E*)

between these compounds is of great interest by itself; the recent suggestion that the steroidal output of the adrenal cortex consists predominantly of compounds *F* and *B* (corticosterone) also should be mentioned here[14]. We are fully aware of variations of the fibrous tumoral effect one meets with in similar experiments even when prolonged for a period of three months, and which may lead to contradictory results. Comparative work with compounds *S* and *F* is continuing in this Department.

The accompanying diagram summarizes the experiments discussed above and also additional experiments with Reichstein's compound *S* and Kendall's compound *F*. Whereas the negative influence of OH--C_{17} (compound *S*) has been fully confirmed, the 'protective' action of OH-C_{11} against OH--C_{17} (compound *F*) remains so far doubtful.



+, Animals with tumours; 0, animals without tumours, only fibrous strands being present; ±, animals with not more than one tumoral note grade 1. Abscissa: absorption of œstradiol per day (μgm.); ordinates: absorption of 3-keto steroids per day (μgm.)

Thanks are due for a generous supply of œstradiol, deoxycorticosterone and compound *S* to Dr. A. White, director of research, and Dr. I. V. Sollins, Chemical Specialties Co., New York, and Syntex, S.A., Mexico; of cortisone to Drs. C. Miescher and A. Wettstein, of Ciba, Basle; and of cortisone, compounds *A* and *F*, to Drs. R. T. Major and A. Gibson, of Merck and Co., Rahway, N.J. Thanks are also due to the Rockefeller Foundation, the Jane Coffin Childs Memorial Fund for Medical Research, and the Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation, for grants afforded in previous phases of our work. The technical help of Mrs. R. A. de Ulloa while working for her M.D. thesis is also acknowledged. [April 16.

[1] Iglesias, R., Lipschutz, A., and Mardones, E., *Nature*, **167**, 235 (1951).
[2] Bruzzone, S., Fuenzalida, F., Iglesias, R., and Lipschutz, A., in "Steroids in Experimental and Clinical Practice", 72 (edit. by A. White: Blakiston Co., Philadelphia, 1951).
[3] Lipschutz, A., Vargas, L., and Nuñez, D., *Proc. Soc. Exp. Biol. Med.*, **48**, 271 (1941).
[4] Lipschutz, A., and Vargas, L., *Lancet*, i, 568 (1941).
[5] Reichstein, T., and Shoppee, C. W., *Vit. and Horm.*, **1**, 345 (1945).
[6] Lipschutz, A., and Zañartu, J., *Endocrinology*, **31**, 192 (1942).
[7] Lipschutz, A., Bruzzone, S., and Fuenzalida, F., *Cancer Research*, **4**, 179 (1944).
[8] Fuenzalida F., *Rev. Can. Biol.*, **3**, 366 (1944).
[9] Mardones, E., Iglesias, R., and Lipschutz, A., *Bol. Soc. Biol. (Santiago)* (in the press).
[10] Lipschutz, A., Iglesias, R., and Mardones, E., *Bull. Ass. Franç. Cancer*, **38**, 394 (1951).
[11] Lipschutz, A., Iglesias, R., Bruzzone, S., Fuenzalida, F., and Riesco, A., *Acta Unio Int. Cancer*, **6**, 85 (1948).
[12] Lipschutz, A., "Steroid Hormones and Tumors" (Williams and Wilkins Co., Baltimore, 1950).
[13] Karnofsky, D. A., *Trans. N.Y. Acad. Sci.*, **13**, 61 (1950).
[14] Conn, J. W., Louis, L. H., and Fajans, S. S., *Science*, **113**, 713 (1951).

PASSAGE OF THE SPERM AND THE PENETRATION OF THE EGG IN MAMMALS

By C. R. AUSTIN and A. W. H. BRADEN

Division of Animal Health and Production, C.S.I.R.O., McMaster Animal Health Laboratory, Parramatta Road, Glebe, N.S.W.

THE wealth of detail in a recent comprehensive review of this subject[1] bears witness to the large volume of information which is available on fertilization and associated phenomena in mammals. Although much of the information is rather disconnected in form, some underlying principles are becoming more clearly defined. In particular, it seems possible now to derive a logical concept of those processes which lead up to the fertilization of the mammalian egg, and it is with this object in mind that the present communication has been prepared. The specific aspects to be considered include the time relations of œstrus, ovulation and coitus, the distribution and rate of travel of sperms in the female genital tract, and the mechanism of sperm penetration into the egg.

Number of Sperms in the Female Tract

The number of sperms in a single ejaculate varies with the species of mammal but generally is of the order of 100 million–1,000 million. The semen may be ejaculated into the uterus, as in the rat, mare and sow, or into the vagina, as in the rabbit, ewe, cow and bitch.

In striking contrast, the number found in the Fallopian tube, and particularly the ampulla, which is the usual site of fertilization, is relatively very small. Mean figures for sperm counts, mostly at the time of ovulation, are available for several species: from 5–43 in the ampulla of the rat[2–4]; 2,000 and 3,000 in the whole tube of the rabbit[2,5]; 5,300 in the whole tube of the ewe[1]; and in the ferret about 200 in the ovarian capsule, which is the probable site of fertilization in this animal[7].

The wide difference which exists between the number of sperms present in the uterus or vagina on one hand and the Fallopian tube on the other, can be imputed to the properties of the female tract and particularly to the utero-tubal junction. The influence of the utero-tubal junction on the distribution of sperms in the genital tract of the rat is clearly shown by the results obtained by Blandau and Odor[4]. The mean number of sperms found in both uteri soon after mating was 58 million, whereas the mean number in the tubes soon after ovulation was 882.

Similarly in the rabbit, Braden (unpublished data) has found that the ratios of the numbers of sperms in the vagina, uteri and tubes of twelve mated rabbits about the time of ovulation was 550 : 450 : 1.

A remarkable degree of selectivity has been demonstrated for the utero-tubal junction of the rat[8]. When rat sperms were mixed with those of the bull, mouse or guinea pig and placed in the uterus, passage into the Fallopian tube was almost completely restricted to the rat sperms.

Time Relations of Sperm Travel

The interval between coitus and the arrival of the first few sperms at the site of fertilization is difficult to establish with certainty, and authorities vary widely in their estimates. The indications are that in many species this interval is remarkably short: times in the neighbourhood of 15 min. or less have been reported for the mouse[9], rat[10], bitch[11], ewe[12] and cow[13]. The brevity of the interval suggests that, at least in these species, the passage of the sperm is effected mainly by the movements of the genital tract, and that the motility of the sperm is of secondary importance.

The interval between coitus and ovulation also varies with species. A few animals, such as the rabbit, ferret and cat, exhibit the phenomenon of copulatory ovulation; the shedding of the egg is controlled by a neuro-hormonal mechanism for which the stimulus is the act of coitus. In most species, however, ovulation occurs independently of mating, though the period of sexual receptivity begins some hours before ovulation. In either circumstance, and where full opportunity exists, there will normally be an interval between coitus and ovulation which may be as short as 10 hr. (rat and rabbit) or as long as 30 hr. (cow and ferret) or several days (mare). Owing to the rapidity of sperm travel, sperms may be present at the site of fertilization for the greater part of these periods before the eggs become available for penetration.

It may happen that, through mischance or experimental intervention, the opportunity for mating is lacking for the early part, or for most, of the period of receptivity. In these circumstances the females of many species will permit coitus shortly before or even a little after ovulation. It has been observed, however, in the rabbit[14], cow[15], ewe[16] and sow[17] that such delayed mating or late artificial insemination results in a reduced incidence of pregnancy and number of young. The effect becomes the more evident the longer the delay; but is noticeable well before the end of the fertile life of the egg.

Penetration of the Egg

The mammalian egg consists of a vitellus enclosed by a thick transparent membrane, the zona pellucida. In the ovary the mature egg is surrounded by a mass of follicle cells, in which two layers are distinguished: an inner layer of densely packed, radially arranged cells, the corona radiata, and an outer layer of sparsely distributed cells, the cumulus oophorus. The cells of the cumulus are embedded in a hyaluronic acid gel which also fills the spaces between the cells of the corona. For a period after ovulation the egg continues to be surrounded by a variable proportion of the follicle cell mass; the amount is large in the rodents and rabbit, moderate in the bitch and cat, and small in the ewe, cow and mare.

To enter the egg, the sperm must traverse the cumulus, corona, zona, and the surface of the vitellus. It appears to be well established now that the sperm penetrates the gel matrix of the first two layers with the aid of the enzyme, hyaluronidase, which it carries[18–20]. The sperm is known to pass through the apparently intact cumulus in the mouse, rat and rabbit, so that actual denudation of the eggs is not a necessary preliminary to penetration[4,9,21,22]. Denudation does occur, but not until later stages of fertilization[9]. Passage through the zona may also be effected by an enzyme, possibly associated with a structure on the leading surface of the sperm head[23,24]. A small slit in the zona of the rat marks the point at which a sperm has entered[25]. The penetration of the vitelline surface, on the other hand, seems rather to be a function of the vitellus which, observed *in vitro*, appears to absorb the sperm[26].

It has long been known that in most invertebrates and lower vertebrates only one sperm normally enters the vitellus and takes part in the process of fertilization. In these species, the entry of more than one sperm into the vitellus, 'polyspermy', has been found to result in early degeneration of the egg. Polyspermy is rare in the mammalian egg, though no detailed study of the incidence or ultimate results of this state appears to have been made. In a recent investigation on the cytology of fertilization[21], only four polyspermic rat eggs were seen among a large series. The bar to polyspermy in mammals is thought to involve a change in the surface of the vitellus. It is certain that the zona offers no protection against polyspermy, for supernumerary sperms are common in the thickness of the zona or in the perivitelline space. Hensen[27] reported the presence of about fifty supernumerary sperms in the rabbit egg, and numbers of the order of 20–30 have been noted recently in a more detailed study[5]. In the rat, it has been found that 23 per cent of eggs contain from 1 to 5 supernumerary sperms[28]. The smaller number seen in rat eggs is consistent with the smaller number of sperms in the Fallopian tubes of this species.

There is no unequivocal evidence of chemotaxis between egg and sperm in animals[29,30]. The chances of penetration may, however, be improved by other mechanisms: the radially arranged coronal cells would tend to direct the movements of the approaching sperm towards the egg; the adherence of the sperm head to the surface of the zona, very evident with the rabbit egg *in vitro*, would have a trap-like action.

Capacitation of the Sperm

Evidence is accumulating that the sperm must remain within the female tract for a period before it is capable of penetrating the egg. If sperms are introduced shortly after ovulation into the perivarian sac of the rat, they are soon found about the eggs in the Fallopian tube, but are not seen within any eggs until four or five hours after their introduction[25]. Similarly, in rats which are not permitted to mate until after ovulation, sperms are found at the site of fertilization one hour after mating, but no penetrated eggs are observed until 2–2½ hours after mating[31].

Failure of penetration, within several hours following the introduction of sperms into the Fallopian tube, has also been reported for the rabbit[25,32].

The main obstacle to penetration appears to be the zona pellucida, and the indications are that the sperm must undergo some form of physiological change or capacitation before it is able to traverse this membrane. Capacitation normally requires residence within the female tract; but recent studies with rabbit eggs suggest that capacitation may occur *in vitro* if sperms are incubated in the presence of tubal secretions[33].

Conclusions

The present trend of research on the processes leading up to fertilization in mammals permits a fuller appreciation of the significance of two phenomena: the distribution of sperms in the female tract and the lapse of time between the onset of sexual receptivity and ovulation.

The weight of evidence now available indicates that the number of sperms which gather at the site of fertilization may be regarded as no more than a compromise between two simple requirements. On one hand, the larger the number of sperms at the site of fertilization the better will be the chances for the meeting of egg and sperm. On the other hand, the danger of polyspermy, from which there is imperfect direct protection, will be reduced in the presence of small numbers of sperms. The problem seems to be resolved by the presence under normal conditions of a small excess of sperms above the minimum necessary to provide good chances for the penetration of all the eggs. The actual number of sperms involved will vary in different species, since the chances of meeting will be influenced by the volumetric capacity of the genital tract and especially the site of fertilization. This control of sperm number is held to be an important and overt function of the female genital tract, and particularly of the uterotubal junction.

The passage of the sperm through the cumulus oophorus is made possible by an enzyme which it carries, and a similar mechanism may enable the sperm to pass through the zona pellucida. An important difference, however, exists between these two processes; for, although the freshly ejaculated sperm is capable of traversing the cumulus, it apparently cannot penetrate the zona until it has undergone some form of physiological change or capacitation.

Time is required for the passage of the sperm to the site of fertilization and for the accumulation there of adequate numbers to provide good chances for the meeting of sperm and egg. The lapse of time between the onset of sexual receptivity and ovulation appears in many species to be well in excess of these requirements. The interval, however, is not unduly long when it is considered that time is needed also for the capacitation of the sperm, which may take much longer than the transit of the sperm, and that some latitude is clearly advantageous as the opportunity for mating may not exist at the beginning of receptivity. It seems probable that the low fertility which has been observed in some species when mating or artificial insemination is performed about the time of ovulation may be imputed to a failure of completion of the capacitation process before the egg nears the end of its fertile life. [May 13.

[1] Chang, M. C. and Pincus, G., *Physiol. Rev.*, **31**, 1 (1951).
[2] Austin, C. R., *Nature*, **162**, 534 (1948).
[3] Blandau, R. J., and Odor, D. L., *Anat. Rec.*, **100**, 733 (1948).
[4] Blandau, R. J., and Odor, D. L., *Anat. Rec.*, **103**, 93 (1949).
[5] Chang, M. C., *Fertility and Sterility*, **2**, 203 (1951).
[6] Warbritton, V., McKenzie, F. F., Berliner, V., and Andrews, F. N., *Proc. Amer. Soc. Anim. Prod.*, 30th meeting, p. 142 (1937).
[7] Hammond, J., and Walton, A., *J. Exp. Biol.*, **9**, 307 (1934).
[8] Leonard, S. L., and Periman, P. L., *Anat. Rec.*, **104**, 89 (1949).
[9] Lewis, W. H., and Wright, E. S., Carnegie Inst. Wash., Contrib. Embryol., **25**, 113 (1935).
[10] Blandau, R. J., and Money, W. L., *Anat. Rec.*, **90**, 255 (1944).
[11] Whitney, L. F., cited by Evans, E. I., *Amer. J. Physiol.*, **105**, 287 (1933).
[12] Starke, N. C., *Onderstepoort J. Vet. Sci. Anim. Indust.*, **22**, 415 (1949).
[13] Vandemark, N. L., and Moeller, A. N., *Amer. J. Physiol.*, **165**, 674 (1951).
[14] Hammond, J., *J. Exp. Biol.*, **11**, 140 (1934).
[15] Trimberger, G. W., Nebraska Agric. Exp. Sta., Res. Bull. No. 153 (1948).
[16] Quinlan, J., Mare, G. S., and Roux, L. L., 18th Rep. Dir. Vet Serv., Union S. Africa, p. 831 (1932).
[17] Lewis, L. L., Oklahoma Agric. Exp. Sta., Bull. No. 96 (1911).
[18] McClean, D., and Rowlands, I. W., *Nature*, **150**, 627 (1942).
[19] Fekete, E., and Duran-Reynals, F., *Proc. Soc. Exp. Biol., N.Y.*, **52**, 119 (1943).
[20] Swyer, G. I. M., *Biochem. J.*, **41**, 409, 413 (1947).
[21] Leonard, S. L., Periman, P. L., and Kurzrok, R., *Proc. Soc. Exp. Biol., N.Y.*, **66** 517 (1947).
[22] Austin, C. R., *Nature*, **162**, 63 (1948).
[23] Green W. W., *Anat. Rec.*, **76**, 455 (1940).
[24] Austin, C. R., and Sapsford, C. S., *J. Roy. Mic. Soc.* (in the press).
[25] Austin C. R., *Aust. J. Sci. Res.*, B, **4**, 581 (1951).
[26] Austin, C. R., *J. Roy. Mic. Soc.*, **71**, 295 (1951).
[27] Hensen, V., *Z. Anat. u. Entwickl.*, **1**, 213 (1876).
[28] Odor, D. L., and Blandau, R. J., *Anat. Rec.*, **104**, 9 (1949).
[29] Buller, A. H. R., *Quart. J. Mic. Sci.*, **46**, 145 (1903).
[30] Tyler, A., *Physiol. Rev.*, **28**, 180 (1948).
[31] Austin, C. R. (manuscript in preparation).
[32] Chang, M. C., *Nature*, **168**, 697 (1951).
[33] Smith, A. U., Biochem. Soc. Symp. No. 7, p. 3 (1951).

SITE OF ACTION OF MUTAGENIC REAGENTS

Nitrogen Mustards

NITROGEN mustards are of interest for the treatment of some types of cancer. We have endeavoured to find the site of action in the cell of one of these compounds (ββ dichlorodiethyl methyl amine) by transfer of nuclei between treated and untreated amœbæ. We have used *Amœba discoides* and *A. proteus*. The figures quoted below are for *A. proteus*.

Amœbæ were given an exposure of fifteen minutes to various concentrations of nitrogen mustard. It is possible to treat either normal amœbæ or enucleated cytoplasm, but not isolated nuclei, with the drug. Transfers of nuclei may then be made between normal amœbæ and treated amœbæ (or cytoplasm). From

examination of such transfers the following conclusions were derived.

(1) The L.D.50 for nuclei is 0·00015 per cent nitrogen mustard.

(2) The L.D.50 for cytoplasm is 0·0015 per cent nitrogen mustard.

(3) The cytoplasm is independently damaged, that is, by a direct action of the drug.

(4) The nuclei are probably damaged independently of the cytoplasm, that is, by a direct action of the drug.

(5) If the cytoplasm is lethally damaged, cell division never occurs.

(6) If the nuclei are lethally damaged, nuclear division usually occurs unless the nuclei are present in very badly damaged cytoplasm. Division of the nuclei is not necessarily followed by cytoplasmic division. If damaged nuclei are in normal cytoplasm, cytoplasmic division normally follows nuclear division; but if the cytoplasm is also damaged the probability of cytoplasmic division varies inversely as the amount of damage.

(7) Division of the amœbæ is delayed to an increasing degree with exposure to increasing concentrations of nitrogen mustard. The first division after treatment is little delayed unless lethal damage has occurred. The second division is much more sensitive than the first, and the delay increases more rapidly with increase in concentration.

(8) Other abnormalities observed included: unequal division; prolonged prophase with death of amœba before completing division; failure of nuclear reconstruction after mitosis; division into more than two cells (up to seven), some of which may be anucleate.

M. J. Ord
J. F. Danielli

Zoology Dept.,
King's College,
London, W.C.2.

X-Rays

In view of the results recorded in the previous communication it was decided to study the site of action of X-rays by a similar technique. Most experiments were made with a 400-kVp. machine, providing a dose-rate of 3,000 r. per minute. Some results were obtained using a 10-kV. machine giving a dose-rate of 27,300 r. per minute. Using the technique of nuclear transfer, the following conclusions were reached with *Amœba proteus*.

(1) The L.D.50 for nuclei is 120,000 r.

(2) The L.D.50 for cytoplasm is 290,000 r.

(3) The cytoplasm is independently damaged, that is, by a direct action of the radiation.

(4) Cytoplasmic damage is of two types: reversible damage already maximal at less than 100,000 r.; and lethal damage becoming prominent above 280,000 r.

(5) The nuclei are probably damaged independently of the cytoplasm.

(6) If the cytoplasm is lethally damaged, cell division never occurs.

(7) If the nuclei are lethally damaged, nuclear division seldom occurs. If division of a lethally damaged nucleus does occur, it is normally followed by cytoplasmic division.

(8) Division of the cytoplasm is delayed and is normally preceded by nuclear division. The delay reaches a maximum at 120,000 r. This delay is prominent for the first division, and small for the second division.

The main differences observed between the action of X-rays and of nitrogen mustard were:

(*a*) The nuclei are ten times more sensitive to nitrogen mustard than is cytoplasm, compared with a ratio of 2·5 for X-rays.

(*b*) The slopes of the dosage-mortality curves both for nuclei and for cytoplasm are steep for X-irradiation and relatively flat for nitrogen mustard. Consequently, a dose of X-rays which is just lethal for all nuclei will not cause any lethal damage to cytoplasms, whereas an exposure to nitrogen mustard which is just lethal to all nuclei will also cause lethal damage to some cytoplasms.

(*c*) Whereas with X-rays delay in division is prominent for the first division and small for the second, with nitrogen mustard the delay is small for the first division and prominent for the second.

(*d*) Lethal damage to nuclei by X-rays usually prevents nuclear division immediately, whereas with nitrogen mustard nuclear division is usually possible after lethal damage.

E. B. Harriss
L. F. Lamerton

Physics Dept.,
Royal Cancer Hospital,
London, S.W.3.

M. J. Ord
J. F. Danielli

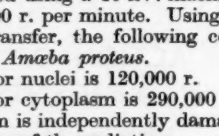
Zoology Dept.,
King's College,
London, W.C.2.

'AZIDINE' TRANSFORMATIONS

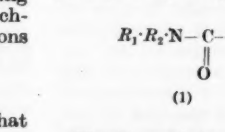
By F. L. Scott, A. Koczarski and Prof. J. Reilly

Department of Chemistry, University College, Cork

The carbamylazides, as a group, were classified by Bertho[1] as resistant to the Curtius rearrangement. However, other work[2] showed that while some members of this group (1, R_1 or R_2 = H, R_2 or R_1 = alkyl/aryl) failed to become rearranged, others (1, R_1 or R_2 = C_6H_5) did so.



(1)



(2)

Hurd[3] explained this anomaly by ascribing a hydroxyurea structure (2, K = OH) to the carbamylazides which resisted rearrangement. Hurd's formula contains the azidine system, a characteristic of which[4] is ready cyclization to substituted tetrazoles, in the presence of bases. (By analogy with the nomenclature change of amide → amidine for the structural change $-CONH_2 \rightarrow -C(=NH)-NH_2$, it is suggested that, for the structural change $-CON_3 \rightarrow -C(=NH)N_3$, the nomenclature change should be from azide → azidine. This latter term does not appear to have been used previously in the literature.) The expected cyclization product from carbamylazide (2, R_1 = H, K = OH) would be 5-hydroxytetrazole (3). Under a wide variety of reaction conditions, and with a large range of basic reagents, we have found

no trace of this cyclized material. Secondly, with ethereal diazomethane[5], two solids were isolated, analyses suggesting that one was a methylated carbamylazide (probably O-methylated since N-methylation with this reagent is rare), the other, of which only traces were found, a polymethylated urea. Because of the structural changes caused by bases, alkaline methylation of the carbamylazide affords different products.

From these observations, carbamylazide appears to display the following tautomerism :

$$NH_2—\underset{\underset{O}{\|}}{C}—N_3 \rightleftharpoons NH=\underset{\underset{OH}{|}}{C}—N_3$$

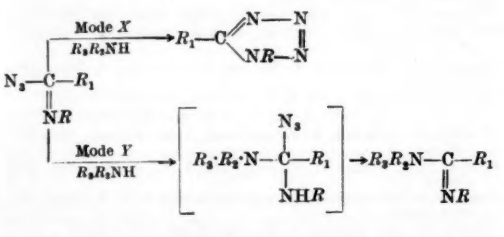
This equilibrium is displaced irrevocably to the right in the presence of diazomethane.

As the Curtius reaction is anionotropic[6], an interpretation, different from Hurd's, for the resistance of carbamylazide to such changes may be suggested. In general, with this type of transformation, the readiness of rearrangement depends upon the electrophilic powers of the migrating groups. Anionotropic migration must exceed the velocity of the other changes which may occur—and competitive reaction may be envisaged, migration velocity (M_v) being necessarily greater than cyclization velocity (C_v) or replacement velocity (R_v)—for reactions of the Curtius type to take place.

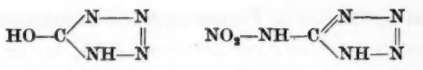
The electrophilic powers of the diphenylimino $(C_6H_5)_2N—$, phenylamino, $C_6H_5NH—$ and the amino radicals are in reciprocal ratios to their basicities ; thus, while the first readily undergoes anionotropic rearrangement (M_v being greater than C_v or R_v), the others, because of their greater basicities, have C_v/R_v greater than M_v and hence fail to undergo the intramolecular migration.

Replacement of the azide group alone is not sufficient proof of the absence of the azidine structure (*vide infra*). However, the observation that no cyclization occurs in the presence of basic reagents too weak to cause replacement was taken as an indication of the absence of azidine nature.

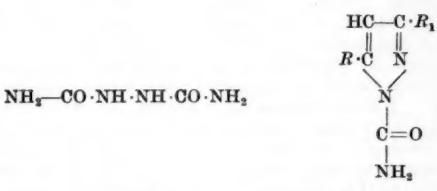
With the azidines the two main courses of reaction which may occur in place of the Curtius type are as follows :



Guanylazide[7] with hydrazine hydrate reacts exclusively by mode Y and with substituted hydrazines[8] by mode X, while nitroguanylazide[9,10] reacts preferentially by mode X in the presence of amines—due to the enhanced acidic powers of 5-nitroaminotetrazoles (4)—but in the presence of hydrazines by mode Y. Usually products derived from simultaneous reactions by both modes X and Y result. A third and rarer course of reaction may occur[11], namely, mode Z, $RC(=K)N_3 \rightarrow RC(=K)N<$ (followed by various modes of decomposition of this free radical, for example, attack of the solvent, to give $RC(=K)N—$ hydrocarbon) ; but only when the Curtius, or the alternatives X or Y, reactions do not take place.



(3) (4)



(5) (6)

With carbamylazide, reaction in the presence of bases is exclusively that formulated in mode Y, and offers a new route for the preparation of ureas (and semicarbazides). From the results of Lieber *et al.*[12], the acid strength of 5-hydroxytetrazole, the possible cyclization product of carbamylazide by mode X, should at least be comparable to that of 5-aminotetrazole and hence should not offer any *a priori* obstacle to the base-produced cyclization. The nature of the azide, then, is apparently the sole determining factor in its stability towards the Curtius transformation.

With amines, reaction is rapid and results in high yields of the monosubstituted compounds. Towards diphenylamine, however, and towards amides and imides, the reagent is inert. With hydrazines, reaction is rapid to yield the monosubstituted semicarbazides ; only with hydrazine itself does a disubstituted product, hydrazodicarbonamide (6), result. Towards 2,4-dinitrophenylhydrazine the reagent is inert. With amino-acids, under a wide variety of conditions, no hydantoins or hydantoic acids result, except in the case of isoleucine.

The ammonolysis of 1-carbamylpyrazoles (6) at present under investigation provides another route to these substituted ureas.

With thiocarbamylazide[13] another mode of reaction takes place, desulphurization occurring as a preliminary to reaction. The further steps, in this case, while not cyanamide formation, as earlier workers believed, are still under investigation. [May 17.

[1] Bertho, A., *J. prakt. Chem.*, **120**, 89 (1929).
[2] Stolle, R., *Ber.*, **57**, 1063 (1924).
[3] Burd, C. D., and Spence, L. U., *J. Amer. Chem. Soc.*, **49**, 266 (1927).
[4] Benson, F. R., *Chem. Rev.*, **41**, 31 (1947).
[5] Arndt, F., *Angew. Chem.*, **61**, 397 (1949).
[6] *Vide* Smith, P. A. S., and Adams, R., "Organic Reactions", **3**, 337 (John Wiley and Sons, Inc., New York, 1949).
[7] O'Connor, T. E., Horgan, K., and Reilly, J., *J. App. Chem.*, **1**, 91 (1951).
[8] Unpublished data.
[9] Scott, F. L., O'Donovan, D. G., and Reilly, J., *J. App. Chem.*, **2**, 368 (1952).
[10] Lieber, E., Sherman, E., Henry, R. A., and Cohen, J., *J. Amer. Chem. Soc.*, **73**, 2327 (1951).
[11] Curtius, T., and Schmidt, F., *J. prakt. Chem.*, **2**, 105, 181 (1926).
[12] Lieber, E., Patinkin, S. H., and Tao, H. H., *J. Amer. Chem. Soc.*, **73**, 1792 (1951).
[13] Freund, M., and Schander, A., *Ber.*, **29**, 2500 (1896). See also Oliveri-Mandala, E., *Gazz. chim. ital.*, **44**, 1, 670 (1914) ; and Sahasrabudhey, R. H., *J. Ind. Chem. Soc.*, **27**, 119 (1950) ; **28**, 524 (1951).

LETTERS TO THE EDITORS

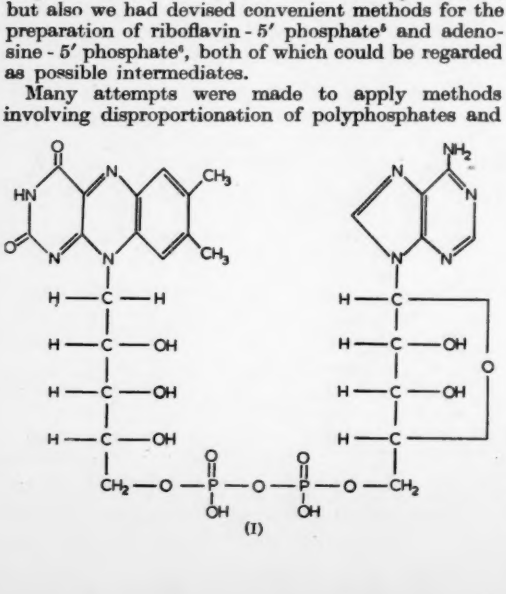
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Total Synthesis of Flavin-adenine-dinucleotide

Flavin-adenine-dinucleotide (FAD) is the co-enzyme of a number of flavoprotein enzymes functioning as oxidation-reduction catalysts in biological systems. Isolated in 1938 by Warburg and Christian[1], it was assigned a probable structure (I) on the basis of available degradative evidence, although its preparation in a pure state has probably been rarely accomplished since its original isolation. Flavin-adenine-dinucleotide is structurally related to several other equally complex coenzymes (for example, coenzymes I and II, uridine-diphosphate-glucose and coenzyme *A*) in that all of them appear to be diesters of pyrophosphoric acid, in which one ester group embraces a pyrimidine or purine nucleoside residue, and indeed the members of the group are usually described loosely as nucleotide coenzymes. No chemical synthesis of any of these coenzymes has hitherto been achieved, although both flavin-adenine-dinucleotide and coenzyme-I have been prepared by enzymic reactions[2].

Over a period of years an extended series of investigations has been undertaken in this laboratory, having as its object the clarification of structural problems in the general field of nucleotide chemistry using the methods of synthetic organic chemistry. These researches have led to the structural elucidation and total synthesis of the ribonucleosides, and the development of a range of flexible methods for phosphorylation and polyphosphorylation of nucleosides[3]. Following the demonstration of the validity of our approach by the synthesis of adenosine triphosphate (ATP)[4], we have devoted increasing attention to the problem of synthesizing unsymmetrical diesters of pyrophosphoric acid of the nucleotide coenzyme type by unambiguous and generally applicable methods. As one of our initial objectives, flavin-adenine-dinucleotide was selected, since not only had riboflavin and adenosine been synthesized, but also we had devised convenient methods for the preparation of riboflavin-5′ phosphate[5] and adenosine-5′ phosphate[6], both of which could be regarded as possible intermediates.

Many attempts were made to apply methods involving disproportionation of polyphosphates and other mixed anhydrides to this problem (notably by Drs. H. S. Forrest and H. S. Mason[7]); but these failed, partly owing to the adverse physical properties of riboflavin and its derivatives, and partly owing to the tendency of the basic catalysts employed to disrupt any flavin-adenine-dinucleotide which might have formed. Arising from this work, however, came an understanding of the behaviour of mixed anhydrides of the oxy-acids of phosphorus, and this provided a novel method for preparing mixed diesters of phosphorous acid which could be applied to the nucleosides. Using it, we were able to synthesize 2′ : 3′-isopropylideneadenosine-5′ benzyl phosphite[8], and from it in turn 2′ : 3′-isopropylideneadenosine-5′ benzyl chlorophosphonate[9]. Condensation of this chlorophosphonate with the monosilver salt of riboflavin-5′ phosphate under carefully controlled conditions yielded the monobenzyl ester of the 2′ : 3′-isopropylidene derivative of (I). Debenzylation, followed by removal of the isopropylidene residue by treatment with acid under conditions which minimized fission of the pyrophosphate linkage, furnished P_1-riboflavin-5′ P_2-adenosine-5′ di-hydrogen pyrophosphate (I), identical with flavin-adenine-dinucleotide from natural sources in chromatographic behaviour (two solvent systems), chemical properties and ultra-violet absorption spectrum. When combined with the flavin-adenine-dinucleotide-free apoenzyme of D-amino-acid oxidase, the synthetic material gave a fully active reconstituted enzyme[10]; in the test solution used the value of 91 per cent was obtained for content of flavin-adenine-dinucleotide as expressed in terms of intensity of light absorption at 450 mμ[1]. We are indebted to Prof. D. Keilin and Dr. E. F. Hartree for carrying out these enzyme experiments.



(I)

This synthesis of flavin-adenine-dinucleotide not only establishes the correctness of structure (I), but it also opens the way to the synthesis of several other nucleotide coenzymes, and experiments in this direction are in progress. Full details of the synthesis here reported will be published elsewhere.

S. M. H. Christie
G. W. Kenner
A. R. Todd

University Chemical Laboratory,
Cambridge. Nov. 6.

[1] *Biochem. Z.*, **298**, 150 (1938).
[2] Shrecker, A. W., and Kornberg, A., *J. Biol. Chem.*, **182**, 795 (1950).
[3] Cf. Review by Kenner, G. W., *Fortschr. Chem. Org. Naturstoffe*, **8** 97 (1951).
[4] Baddiley, J., Michelson, A. M., and Todd, A. R., *J. Chem. Soc.*, 582 (1949).
[5] Forrest, H. S., and Todd, A. R., *J. Chem. Soc.*, 3295 (1950).
[6] Baddiley, J., and Todd, A. R., *J. Chem. Soc.*, 648 (1947).
[7] Forrest, H. S., Mason, H. S., and Todd, A. R., *J. Chem. Soc.*, 2530 (1952).
[8] Corby, N. S., Kenner, G. W., and Todd, A. R., *J. Chem. Soc.*, 3669 (1952).
[9] Kenner, G. W., Todd, A. R., and Weymouth, F. J., *J. Chem. Soc.*, 3675 (1952).
[10] Keilin, D., and Hartree, E. F., *Nature*, **157**, 801 (1946).

Evolution of Animal Fats

Using the theory of evolution as a general background, Hilditch and Lovern[1] have directed attention to the gradual simplification in the fatty-acid composition of animal fats as one proceeds from the lower forms of life to those that are more highly organized. In particular, they have noted the striking

difference between the complexity of the fats of aquatic animals, which contain, in addition to C_{14}, C_{16} and C_{18} saturated acids, a wide range of unsaturated acids of the C_{14}, C_{16}, C_{18}, C_{20} and C_{22} series, as compared with the fats of the more highly evolved land mammals, which generally contain as major components only three acids, palmitic, stearic and oleic.

From consideration of the results[2] of the Fats Research Laboratory, New Zealand, together with those of other workers, however, it is suggested that the observed increasing simplicity of animal fats, as one proceeds from the lower to the more highly organized forms of animal life, is largely due to the fortuitous influence of the diet and only in part to the animals themselves. Thus, for example, aquatic mammals or birds deposit fats which are of the complex aquatic type, whereas land mammals or birds, which feed on fats of relatively simpler composition, deposit simpler types of fats[3]. On the other hand, it is now suggested that the major trend of evolutionary development on fats is discernible with respect to the fat metabolism of animals as follows:

(*a*) In the early stages of evolutionary development of fats in animals, the organism, as exemplified by fishes, is able to assimilate the dietary fat and so deposit it in its tissues more or less in the form present in the diet, subject, of course, to minor modifications induced by hydrogenation, dehydrogenation and in some instances to lengthening or shortening of the carbon chains. At this stage of development, the organism is apparently unable to make fat[4] (here termed 'synthetic' fat) from the non-fatty (protein and carbohydrate) constituents of the diet.

(*b*) In the next stage, as exemplified by amphibians, reptiles and most mammals, there is acquired, in addition to the ability to deposit the dietary fat mainly in its original form in the depot fat, an ability to make 'synthetic' fat. Such 'synthetic' fat is more or less of a uniformly simple composition and contains, as its main components, palmitic, stearic and oleic acids. The final composition of the depot fats of these animals will largely depend on the relative proportions of the dietary and of the 'synthetic' fats.

(*c*) In the final stage, the organism, as exemplified by certain ruminants, largely loses the power to deposit the fat from the diet[2], the constituents of which are broken down by the bacteria of the rumen before assimilation by the animal. The dietary fat no longer has any appreciable influence on the composition of the depot fat, which now consists almost entirely of 'synthetic' fat, with palmitic, stearic and oleic acids as the major constituents.

From the above conception of the factors which determine the fatty-acid composition of the depot fats of animals, it follows that the complexity of the fats of the less highly organized animals, such as fishes, is largely due to the fatty-acid composition of the diet, as, indeed, is indicated by the fact that fish, when fed unusual diets, will deposit in their depots fats which are different from the usual aquatic type. For example, grass-fed carp deposit in their fatty depots the diene and triene acids, characteristic of the grass lipids, but not characteristic of the fats of other aquatic species[5]. Eels, when fed fats of fatty-acid composition different from that originally present in their depots, have been shown to modify their depot fat to resemble more closely the dietary fat[6]. Further, it follows that if the dietary fat was similar in fatty-acid composition to that of 'synthetic' fat, all groups of animals would tend to lay down fats of somewhat similar fatty-acid composition; but if fed a dietary fat of different fatty-acid composition as, for example, linseed oil, then differences in fatty-acid composition of the depot fats would be observed as follows. Animals which had reached the first stage of development in regard to fat metabolism (*a*) would have fat in their depots of which the fatty-acid composition resembled that of linseed oil. Animals in the second stage of development (*b*) would lay down fats consisting of a mixture of 'synthetic' fat and linseed oil, the proportions of the latter in the depot fats depending on the proportions in the diet and on the rate of growth (cf. Callow[7]), whereas animals in the third stage of development (*c*) would show in their depots no appreciable evidence of linseed oil, but their fat would consist almost entirely of the 'synthetic' type.

From the work of Anderson[8], it is apparent that bacilli are able to synthesize lipids from non-fatty sources. The fatty material in this instance, however, is non-glyceridic in nature and, moreover, contains, for the most part, branched-chain fatty acids in contrast to the straight-chain even-numbered carbon-atom acids characteristic of the rest of animal and plant life.

Consideration of the nature of the bacillary lipids in relation to those already described above suggests that the evolution of fatty substances has commenced and ended with forms that are capable of making fats from non-fatty sources but incapable of depositing the dietary fat in their depots. The complexity of the fatty materials synthesized by bacilli from non-fatty sources, however, contrasts strikingly with the relative simplicity of the fats synthesized in the depots of ruminants. The evolution of fats thus appears to illustrate the loss and recovery of function, albeit in a somewhat changed form, during the development of the organism from less-specialized into more-specialized forms, and the discovery of branched-chain fatty acids in fats of ruminants[9] may be evidence of a vestigial characteristic carried through during development from bacteria to the more specialized forms of life.

F. B. Shorland
Fats Research Laboratory,
Department of Scientific and Industrial Research,
Wellington, N.Z.
July 19.

[1] Hilditch, T. P., and Lovern, J. A., *Nature*, **137**, 478 (1936).
[2] Shorland, F. B., *Nature*, **165**, 766 (1950).
[3] Hilditch, T. P., "The Chemical Constitution of Natural Fats", 2nd edit. (Chapman and Hall, Ltd., London, 1947).
[4] Lovern, J. A., Biochem. Soc. Sym. No. 6, Cambridge, 49 (1951).
[5] Green, T. G., and Hilditch, T. P., *J. Soc. Chem. Indust.*, **55**, 4T (1936).
[6] Lovern, J. A., *Biochem. J.*, **32**, 1214 (1938).
[7] Callow, E. H., Rep. Food Invest. Bd., Lond., 43 (1935).
[8] Anderson, R. J., *Chem. Revs.*, **29**, 225 (1941).
[9] Hansen, R. P., and Shorland, F. B., *Biochem. J.*, **50**, 207 (1951).

Dr. F. B. Shorland's letter on this subject may serve to direct attention to the large number and variety of animal fats the component acids of which are now known with adequate quantitative accuracy. This number is nevertheless still small in comparison with the large number of species of which the fats await similar study.

Dr. Shorland's conclusions in regard to the progressive changes in the capacity of animals to produce

comparatively simple 'synthetic' fats consisting mainly of combined palmitic, stearic and oleic acids as well as, or instead of, merely assimilating dietary fat are constructive and broadly accord with the general trend of the facts so far elicited. At the same time, as one would expect in so complex a field, many animal fats do not appear at first sight to fall smoothly into place in his classification. A few instances may be mentioned here which suggest that Shorland's outline is, as he would doubtless agree, in the nature of a preliminary statement which will require in due course further elaboration or modification.

(*a*) The variation of fatty-acid composition within the complex types of marine animal fats is probably as great as that which characterizes fats of his second and third classes (amphibians, reptiles and mammals). This is seen in an extreme degree in the diverse fats of such species as the balænic whales, the sperm whales and the dolphin and porpoise family; but it also obtains to a lesser extent in those of many species of fish. This leads one on one hand to feel that Shorland may attach less importance than is necessary to the effect of species and too much to the "fortuitous influence of the diet", and on the other hand to inquire whether it is adequately established that marine animals derive all their fat from preformed dietary sources. Profound modification of dietary fat would appear essential to produce, for example, the characteristic wax-esters of the Physeteridæ or the isovaleric glycerides of the Delphinidæ.

(*b*) Shorland's intermediate stage (*b*), at which animals may acquire the ability to make 'synthetic' fat, more or less of a uniformly simple composition with palmitic, stearic and oleic acids as its main components, would seem to include a variety of species, but at the same time to exclude others which are at an equivalent or parallel stage of development. Thus fats of the type indicated, and usually rich in stearic acid, are deposited not only by ruminants but also by a wide range of other animals, including the feline tribe[1-3], the kangaroo[3], hippopotamus[4] and elephant[5]. In contrast, other equally developed animals, such as bears[3], apes[3] and human beings[3], produce fats with much higher proportions of oleic (and sometimes hexadecenoic) acid than the former group, but containing comparatively small amounts of stearic acid and sometimes less palmitic acid than the 'normal' animal fat figure[7] of 30 ± 3 per cent (mol.) of the total acids.

(*c*) It is clear that whereas ruminants produce to a major degree the simpler type of 'synthetic' fat rich in palmitic, stearic and oleic acids, the pig also normally synthesizes[8] similar kinds of 'synthetic' fat (poorer in stearic and richer in oleic acid) but is equally capable of assimilating in addition fats present in its food[9]. It has recently been shown[10] that the body fats of a pig fed freely on whale oil consisted substantially of mixtures of almost unchanged whale oil glycerides with typical 'synthetic' pig-fat glycerides.

The horse presents another instance which seems not to fit in Shorland's generalization, for as he[11] and others[12] have shown, the fat of pasture-fed horses contains notable amounts of linolenic acid apparently absorbed from the grass glycerides. It is indeed a striking example of species influence that fats of entirely different composition are produced by a horse, an ox, and a sheep feeding on the same field of pasture.

(*d*) Lastly, it should not be overlooked that the very small amounts of branched-chain acids recently shown to be present in certain animal fats may well arise, not from the true fat, but from sweat gland waxes or similar sources which have accidentally passed into the fat during its preparation from the animal tissue.

T. P. Hilditch

32 Beresford Road,
Oxton, Birkenhead.
Sept. 10.

[1] Giral, F., *J. Chem. Soc.*, 112 (1945).
[2] Pathak, S. P., and Godbole, N. N., *Indian Soap J.*, **11**, 68 (1945).
[3] Hilditch, T. P., Sime, I. C., and Maddison, L., *Biochem. J.*, **36**, 98 (1942).
[4] Barker, C., and Hilditch, T. P., *J. Chem. Soc.*, 3141 (1950).
[5] Cama, J. C., and Meara, M. L. (personal communication).
[6] Cramer, D. L., and Brown, J. B., *J. Biol. Chem.*, **151**, 427 (1943).
[7] Banks, A., and Hilditch, T. P., *Biochem. J.*, **25**, 1168 (1931). Hilditch, T. P., and Longenecker, H. E., *ibid.*, **31**, 1805 (1937).
[8] Ellis, N. R., and Zeller, J. H., *J. Biol. Chem.*, **89**, 185 (1930). Hilditch, T. P., Lea, C. H., and Pedelty, W. H., *Biochem. J.*, **33**, 493 (1939).
[9] Ellis, N. R., and Isbell, H. S., *J. Biol. Chem.*, **69**, 239 (1926). Ellis, N. R., Rothwell, C. S., and Pool, W. O., *ibid.*, **92**, 385 (1931).
[10] Garton, G. A., Hilditch, T. P., and Meara, M. L., *Biochem. J.*, **50**, 517 (1951).
[11] Brooker, E. G., and Shorland, F. B., *Biochem. J.*, **46**, 80 (1950).
[12] Gupta, S. S., and Hilditch, T. P., *Biochem. J.*, **43**, 137 (1951).

Anti-mutagens

While studying the mutagenic action of various purine derivatives on bacteria, we came across a new phenomenon: we found that certain nucleosides can act as anti-mutagens.

Following the discovery[1] that caffeine—a purine derivative—increases the mutation-rate in fungi and in bacteria, we began a quantitative study of the mutagenic action of purine derivatives. Such a study has been made possible by the use of a constant flow device, called the 'Chemostat'[2-4], which maintains a stationary bacterial population growing at a fixed rate that can be set at will. The concentration of the bacterial population maintained in the growth tube of the 'Chemostat' is determined by the input concentration of one of the required nutrients, called the controlling growth factor, and the growth-rate is fixed by the rate at which fresh nutrient flows into the growth tube.

A variety of different mutations will occur at different rates in such an otherwise stationary population, and if one plots the concentration of one

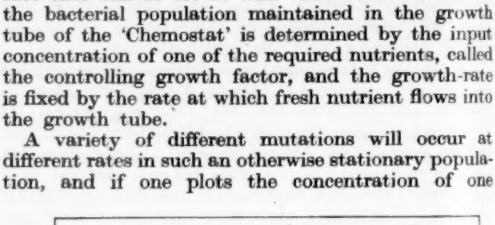


Fig. 1

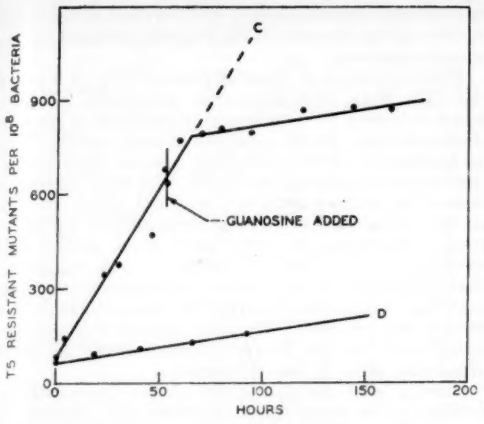


Fig. 2

particular type of mutant against time, one should obtain a straight line which rises with a slope that is determined by the mutation-rate. This holds for each type of mutant which grows at the same rate as the parent strain, that is, if there is no selection for or against the mutant. If there is selection against a mutant, the concentration of that mutant will remain stationary after an initial rise.

In the experiments to be reported here, we used a strain of *E. coli* (*B*/1*t*) requiring tryptophane, and used tryptophane as the controlling growth-factor. This organism is sensitive to the bacteriophage *T*5. Mutants resistant to *T*5 present at any given time in the population growing in the 'Chemostat' can be scored by colony count simply by adding a small quantity of the virus *T*5 to an aliquot at the time of plating; in the presence of the virus, only the resistant mutants will grow out into colonies.

As we reported earlier[3], mutation to *T*5 resistance occurs at a constant rate independent of the rate at which the bacteria grow, that is, independent of the generation-time of the bacteria. By plotting against time the number of *T*5-resistant mutants present in the growth tube of the 'Chemostat', one obtains curve *A* of Fig. 1. The slope of this straight line gives a mutation-rate $\mu = 1{\cdot}4 \times 10^{-8}$/bacterium/hr.

When the nutrient medium contains theophylline (a dimethylxanthine) in a concentration of 150 mgm./l., the number of mutants rises very quickly, corresponding to the straight line *C* in Fig. 2, giving a mutation-rate of $10{\cdot}7 \times 10^{-8}$/bacterium/hr. This represents a seven-fold increase in the mutation-rate, which we attribute to the mutagenic action of theophylline. However, if the nutrient contains, in addition to 150 mgm./l. of theophylline, 50 mgm./l. of the nucleoside guanosine, the number of mutants rises much more slowly, as shown by line *D* in Fig. 2. The slope of this line corresponds to a mutation-rate of about 1×10^{-8}/bacterium/hr., indicating that guanosine, in the concentration used, completely counteracts the mutagenic action of the theophylline.

In the experiment mentioned earlier, which is described in the upper curve in Fig. 2, the bacterial population is first grown (at a generation-time of 3·2 hr.) in the presence of 150 mgm./l. of theophylline with no guanosine present. After 53 hr., guanosine is added to give a concentration of 150 mgm./l. For the first 53 hr. and for a short time thereafter, the number of mutants follows the straight line *C*, which gives a mutation-rate of $10{\cdot}7 \times 10^{-8}$/bacterium/hr.; but afterwards the number of mutants follows another straight line which gives a mutation-rate of less than $1{\cdot}5 \times 10^{-8}$/bacterium/hr. The two straight lines intersect, not at the time when the guanosine is added, but about 12 hr. later.

In order to explain this 12-hr. delay in the fall of the mutation-rate after adding guanosine, we do not have to assume that it takes that time for the guanosine to counteract the mutagenic effect of theophylline, but may attribute the delay to the fact that mutations are not immediately expressed in the phenotype of the bacteria. When the guanosine is added, the mutations induced by theophylline may very well cease to occur; but the mutations induced prior to the addition of guanosine continue to be expressed phenotypically for a period of about 12 hr.

The results shown in Fig. 2 have to be interpreted as an actual reduction of the mutation-rate by guanosine; that is, they cannot be attributed to a selection against the bulk of *T*5-resistant mutants resulting from the presence of guanosine. It is easy to show that if such a selection were responsible for the low mutation-rate shown by line *D* in Fig. 2, then in the upper curve in Fig. 2 the number of mutants resistant to *T*5 should fall steeply after adding guanosine at the 53rd hour.

The concentration of guanosine needed to counteract the mutagenic effect of 150 mgm./l. of theophylline is quite low. For a concentration of about 2 mgm./l. of guanosine, the rate of mutation induced by theophylline falls to one-half.

The other normally occurring purine ribosides were examined for anti-mutagenic action at concentrations of 5 mgm./l. At this concentration adenosine and inosine are strongly anti-mutagenic against theophylline, whereas xanthosine has no such activity. In contrast to inosine itself, its components, that is, the free purine hypoxanthine and the free sugar ribose, are not anti-mutagenic even at concentrations of several hundred milligrams per litre.

A concentration of 500 mgm./l. of guanosine gives practically complete suppression of the mutagenic action of the following purine derivatives (at concentrations of 150 mgm./l.): theophylline, caffeine, theobromine, paraxanthine, and 8-azaguanine. But tetramethyluric acid and benzimidazole retain more than half their mutagenic effect.

One may ask what effect guanosine has on the spontaneously occurring mutations. As can be seen from line *B* in Fig. 1, 50 mgm./l. of guanosine gives a mutation-rate of $0{\cdot}6 \times 10^{-8}$/bacterium/hr., that is, one-half to one-third as much as the spontaneous mutation-rate derived from curve *A*. This shows that guanosine in the concentration used reduces the mutation-rate to *T*5 resistance appreciably below the spontaneous mutation-rate.

Aaron Novick
Leo Szilard

Institute of Radiobiology and Biophysics,
University of Chicago,
Illinois.
July 30.

[1] Fries, N., and Kihlman, K., *Nature*, **162**, 573 (1948). Demerec, M., Bertani, G., and Flint, J., *Amer. Naturalist*, **85**, 119 (1951).
[2] Novick, A., and Szilard, L., *Science*, **112**, 715 (1950).
[3] Novick, A., and Szilard, L., *Proc. U.S. Nat. Acad. Sci.*, **36**, 708 (1950)
[4] Monod, J., *Ann. Inst. Pasteur*, **79**, 390 (1950). Novick, A., and Szilard, L., *Cold Spring Harbor Symp. Quant. Biol.*, **16**, 337 (1951).

Agglutination Reactions in Human Red Cells Fragmented by Heat

Murray and Clark[1] have shown that, if red cells are heated to 50° C., substances can be obtained from the surrounding fluid which, even if derived from *Rh*-negative red cells, can give rise to anti-*D* agglutinins when injected into guinea pigs. Temperatures in the neighbourhood of 50°–56° produce extensive modifications of the human red-cell surface, namely, fragmentation, development of myelin forms, and, at the higher temperatures, hæmolysis[2]. It is therefore likely that the substances found by Murray and Clark in the fluid surrounding the heated cells are the products of the fragmentation phenomena and the changes in the red-cell surface which accompany them.

Thrice-washed human red cells (group *O, CDE* positive) are heated for 10 min. at 50°, 52°, 54° and 56° C., and then tested for their reactivity with anti-*D* serum at 37° C. As the temperature is increased, the fragmentation and hæmolytic phenomena become more and more pronounced, as already described[2], and as can be seen by examining the suspensions by phase contrast. At the same time, the serological reactivity of the red cell surface becomes modified. Agglutination by 'complete' (saline agglutinin) antibody becomes progressively weaker as the temperature to which the cells are heated is increased, and is almost lost after heating to 56° C. However, cells which have been heated even to 56° C. will react with 'incomplete' (blocking) antibody, as shown by a positive indirect Coombs reaction. The cell surface is not modified to such an extent, however, as to give a positive direct Coombs reaction.

Similar experiments show that heating progressively decreases the trypsinizability of red cells, and progressively decreases the reactivity of red cells which have been trypsinized before the heating.

The material obtained by ultracentrifuging the heated preparations, that is, the material which Murray and Clark find to be antigenic in the guinea pig, consists of tiny fragments and myelin forms. The reactivity of their surfaces, however, is so reduced that no agglutination-like phenomena can be produced by the addition of anti-*D* sera.

Ruth Ponder
Eric Ponder

Nassau Hospital,
Mineola, N.Y. Aug. 5.

[1] Murray, J. M., and Clark, E. C., *Nature*, **169**, 887 (1952).
[2] Ponder, E., *J. Exp. Biol.*, **26**, 35 (1949); **27**, 198 (1950).

Pseudo-Cholinesterase of Brain

Shortly after the distinction had been made between the true cholinesterase and the pseudo-cholinesterase[1,2], it was claimed that the brains of vertebrates contain true cholinesterase only[3]. This latter statement has proved to be incorrect; when large amounts of tissue are used for cholinesterase determinations, the presence of a small amount of pseudo-cholinesterase in brain can be demonstrated[4,5]. Experiments with selective inhibitors of pseudo-cholinesterase have rendered it highly improbable that this enzyme would have any important role in the hydrolysis of acetylcholine released at nerve endings[6–8]. However, the pseudo-cholinesterase in brain appears to be associated particularly with the myelinated fibre tracts of the central nervous system, and it has been suggested that the activity of this esterase may be connected with processes occurring in the myelin sheaths or neuroglial elements of the nervous system[5].

This suggestion is especially interesting in view of the fact that tri-ortho-cresyl phosphate (TOCP), which is known to be a selective inhibitor of pseudo-cholinesterase[5], causes paralysis in many species with demyelination of the peripheral nerves, degenerative changes in the anterior horn cells, and fatty degeneration in the white matter of the spinal cord[9]. Studies on the inhibition of the cholinesterases by tri-ortho-cresyl phosphate *in vitro* have been carried out recently by Earl and Thompson[10], who suggested that inhibition of the pseudo-cholinesterase by this substance might play a part in the demyelination and consequent paralysis. We have also investigated the significance of the pseudo-cholinesterase in brain along two lines in our laboratory.

First, a very detailed study on the cholinesterase activity of ox brain failed to reveal the presence of any pseudo-cholinesterase, thus confirming a previous report[11] on the absence of pseudo-cholinesterase in various other tissues of this species and of the sheep. The absence of pseudo-cholinesterase from the tissues of ruminants shows that the paralysis due to tri-ortho-cresyl phosphate, which can also be produced in ruminants[9,12,13], is not likely to be due to inhibition of pseudo-cholinesterase.

Nevertheless, we thought it necessary to substantiate this conclusion by inhibiting the pseudo-cholinesterase in a species the brain of which does contain this enzyme. Three groups of young male rats of a crossed Wistar-piebald strain, weighing between 75 and 85 gm., were used in this experiment. One group served as controls, the second group was injected subcutaneously with 0·5 ml. tri-ortho-cresyl phosphate, while the third group was injected intramuscularly with 0·05 ml. and after six weeks with 0·1 ml. of this substance. The injections were repeated every four days for three weeks, and from then on once a week for a total period of fourteen weeks. Animals were sacrificed at various times to determine the cholinesterase activities of the tissues by the methods described by Mendel *et al.*[2] and Thompson *et al.*[5,10]. The cholinesterase activities of the tissue homogenates were determined manometrically with 0·03 *M* acetyl-β-methylcholine[2] as specific substrate for the true cholinesterase, and 0·006 *M* benzoylcholine[2] and 0·03 *M* butyrylcholine[5,10] as specific substrates for the pseudo-cholinesterase. Esterase activities are expressed as μl. carbon dioxide produced per hr. per 100 mgm. tissue or per ml. serum (see table). The rats of group II were injected subcutaneously with 0·5 ml. tri-ortho-cresyl phosphate and those of group III intramuscularly with 0·1 ml. In both groups of rats treated with tri-ortho-cresyl phosphate, the pseudo-cholinesterase of brain was almost completely inhibited from the seventh day until the end of the experiment.

During this period of fourteen weeks, each of the seven remaining rats of the second group gained about 160 gm. on the average, those of the third group 300 gm. and the control animals 320 gm. Despite the complete and prolonged inhibition of the pseudo-cholinesterase in brain, none of the animals showed any signs of paralysis. The rats of the third group were indistinguishable in appearance from the controls; histological examination of the brain, spinal cord and sciatic nerves of these animals did not reveal any demyelination or other abnormalities.

INHIBITION OF THE CHOLINESTERASES OF RAT BRAIN AND OTHER TISSUES AFTER INJECTIONS OF TRI-ORTHO-CRESYL PHOSPHATE FOR 14 WEEKS

Tissue	Group No.	True cholinesterase activity	Pseudo-cholinesterase activity	
			Benzoylcholine	Butyrylcholine
Cerebellum	control	96	8	38
	II	28	—	0
	III	52	—	0
Cerebrum	control	476	7	52
	II	133	—	0
	III	218	—	0
Thalamus, pons and medulla	control	286	26	146
	II	86	0	0
	III	185	0	2
Heart	control	29	155	830
	II	11	0	10
	III	16	10	54
Liver	control	—	37	210
	II	—	0	5
	III	—	2	18
Small intestine	control	—	184	960
	II	—	0	18
	III	—	26	148
Serum	control	160	78	416
	II	102	6	38
	III	150	16	82

Two conclusions can be drawn from these experiments. First, the integrity of medullated nerve fibres does not seem to depend on the activity of the pseudo-cholinesterase in the myelin sheaths; secondly, the pseudo-cholinesterase is not required for the hydrolysis of acetylcholine released by nervous activity in the brain.

B. MENDEL
D. K. MYERS

Pharmaco-therapeutic Laboratory,
University of Amsterdam. July 21.

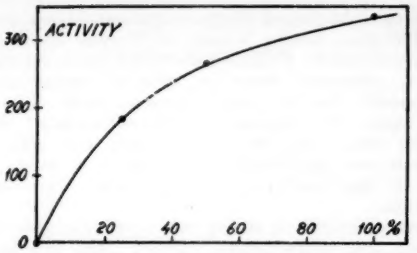
[1] Mendel, B., and Rudney, H., *Biochem. J.*, **37**, 53 (1943).
[2] Mendel, B., Mundell, D. B., and Rudney, H., *Biochem. J.*, **37**, 473 (1943).
[3] Mendel, B., and Rudney, H., *Science*, **98**, 201 (1943).
[4] Burgen, A. S. V., and Chipman, L. M., *J. Physiol.*, **114**, 296 (1951).
[5] Ord, M. G., and Thompson, R. H. S., *Biochem. J.*, **51**, 245 (1952).
[6] Mendel, B., and Rudney, H., *Science*, **100**, 499 (1944).
[7] Hawkins, R. D., and Gunter, J. M., *Biochem. J.*, **40**, 192 (1946).
[8] Hawkins, R. D., and Mendel, B., *Brit. J. Pharmacol.*, **2**, 173 (1947).
[9] Smith, M. I., and Lillie, R. D., *Arch. Neurol. Psychiat.*, **26**, 976 (1931).
[10] Earl, C. J., and Thompson, R. H. S., *Brit. J. Pharmacol.*, **7**, 261 (1952).
[11] Gunter, J. M., *Nature*, **157**, 369 (1946).
[12] Smith, M. I., Elsvove, E., and Frazer, W. H., *Pub. Health Rep.*, **45**, 2509 (1930).
[13] Draper, H. H., James, M. F., and Johnson, B. C., *Fed. Proc.*, **11**, 204 (1952).

Isolation of a Soluble Fibrinolytic Activator from Animal Tissue

ANIMAL tissue contains a fibrinolytic activator (fibrinokinase) which cannot be brought into aqueous solution by the usual procedures for extracting biologically active substances[1]. This observation was confirmed by Tagnon[2] and by Lewis and Ferguson[3], who found that the microsome fraction of the disintegrated tissue was particularly active.

When bovine lung tissue was treated as described for the preparation of fibrinokinase, no fibrinolytic activator was obtained, but the tissue acted as a powerful inhibitor of trypsin and plasmin[4]. Recently[5], we succeeded in isolating from this tissue a soluble protease inhibitor by extraction with potassium thiocyanate, performed as described by Snellman, Jensen and Sylvén[6] for the isolation of heparin from animal tissue.

We have now found that a similar treatment of the insoluble fibrinokinase preparation yields the fibrinolytic activator in a water-soluble form. Thus a fibrinokinase preparation made in the usual manner from pig hearts was treated for one hour with *M* potassium thiocyanate. The tissue was removed by pressing through gauze and the solution was dialysed against diethylbarbiturate buffer (*p*H 7·8, $\mu = 0{\cdot}05$). The resulting solution showed a high activating power on plasminogen. The substance was obtained as a dry powder by precipitation with acetone and drying with acetone and ether, yield about 100 mgm. per gm. of crude material.



Activity (ordinate) of increasing concentrations (abscissa) of a stock solution (7 mgm./ml.) of the soluble fibrinolytic activator, recorded as the product of two perpendicular diameters of the lysed zones. Substrate: bovine fibrin containing plasminogen

The product obtained was not completely soluble in the buffer, but its solution showed a high fibrinolytic activity when tested by the usual fibrin plate method, where plasminogen is present in the substrate (see graph). On fibrin plates containing no plasminogen (prepared as described elsewhere[7]) no activity was found.

In view of this successful isolation of a soluble fibrinolytic activator from animal tissue, it might be interesting to investigate the possibility of using a solution of potassium thiocyanate in the extraction of other enzymatic substances which are found to occur preferably in the so-called mitochondria and microsome fractions of disintegrated tissue[8].

This work was aided by a grant from Det teknisk-videnskabelige Forskningsraad, Copenhagen.

TAGE ASTRUP
AGNETE STAGE

Biological Institute, Carlsberg Foundation,
Copenhagen. May 30.

[1] Astrup, T., and Permin, P. M., *Nature*, **159**, 681 (1947). Permin, P. M., *Nature*, **160**, 571 (1947); *Acta Physiol. Scand.*, **21**, 159 (1950). Astrup, T., *Acta Physiol. Scand.*, **24**, 267 (1951).
[2] Tagnon, H. J., and Petermann, M. L., *Proc. Soc. Exp. Biol. Med.*, **70**, 359 (1949). Tagnon, H. J., and Palade, G. E., *J. Clin. Invest.*, **29**, 317 (1950).
[3] Lewis, J. H., and Ferguson, J. H., *J. Clin. Invest.*, **29**, 1059 (1950).
[4] Astrup, T., *Acta Physiol. Scand.*, **26**, 243 (1952).
[5] Astrup, T., *Acta Hæmatologica*, **7**, 271 (1952).
[6] Snellman, O., Jensen, R., and Sylvén, B., *Nature*, **161**, 639 (1948).
[7] Lassen, M., *Acta Physiol. Scand.* (in the press).
[8] Schmitt, F. O., "Advances in Protein Chemistry", **1**, 25 (1944). Claude, A., *ibid.*, **5**, 423 (1949).

Rapid Restitution of the Rat Pancreas following Acinar Cell Necrosis Subsequent to Ethionine

ONLY rarely has the suggestion been made that the pancreas, human[1] or animal[2], possesses the faculty of complete regeneration. Ethionine, a metabolic analogue of methionine, produces acinar cell necrosis of the pancreas[3]. Rats show within one to two weeks after pancreatic acinar cell necrosis a relatively complete restitution of the organ.

Thirty-eight fasted Wistar white rats, both sexes, 160–190 gm., having access to 'Purina' chow and water were used. Fourteen were each given 50 mgm. of D-L ethionine daily in distilled water intraperitoneally for 14 days. Sixteen each received 100 mgm. of ethionine intraperitoneally daily for 10 days. Six rats were used for controls. Animals were sacrificed at 2, 4, 6, 7, 8, 10, 14, 21 and 28 days and nine months after the initial injection.

Animals sacrificed during ethionine administration showed the characteristic effect[3]. On the lower dosage, complete acinar cell necrosis was seen by the tenth day. Ducts and islets were not involved. Regeneration, indicated by cells in mitosis, or cells with deeply basophilic cytoplasm and large nuclei, was noted on the seventh day. At the fourteenth day regenerating cells were frequent and lobule formation beginning. Seven days after cessation of ethionine, normal architecture was demonstrated by discreet lobules, well-formed acini, and zymogen granules in the apical cytoplasm. Seven days later, a few cytoplasmic vacuoles in the acinar cells were the only abnormality. Weakness, and severe loss of weight, progressing from the fifth day, were followed by clinical recovery within a day or two after cessation of the drug.

With the higher dosage, effects were similar but more pronounced. By the eighth day, acinar cells had disappeared and only intact duct and islet cells, inflammatory cells and small groups of regenerating, spindle mononuclear cells were present. Four days after cessation of ethionine, many mitotic figures, incipient lobule formation and acinar cells with basal basophilia were noted. At eleven days after treatment there was restitution of normal architecture, with zymogen granules present in the acinar cell cytoplasm and frequent mitotic figures. One animal sacrificed 18 days after drug cessation showed only minimal restoration. All other animals killed one to two weeks after the cessation of the drug showed restitution of the gland. Two animals, each of which received a second course of ethionine after recovery from the initial dosage, revealed no pancreatic abnormalities nine months later. Control animals had normal organs.

The high protein and enzyme content of the pancreas, and the significance of these substances in problems of growth, differentiation and neoplasia, suggest a possible experimental use of the pancreatic recovery from the effect of ethionine in these fields. Morphological destruction and restitution of a specific cell-type following the use of an analogue provides a means of exploring facets of methionine antimetabolites.

Patrick J. Fitzgerald
Mario Alvizouri

Division of Pathology,
Memorial Hospital,
and Department of Physics,
Sloan Kettering Institute,
Memorial Hospital Center
for Cancer and Allied Diseases,
New York, N.Y.
July 21.

[1] Parker, F., jun., *J. Med. Res.*, **40**, 471 (1919).
[2] Bensely, R. R., "Harvey Lectures", 1914–1915, 250 (J. B. Lippincott Co., Philadelphia, 1915).
[3] Farber, E., and Popper, H., *Proc. Soc. Exp. Biol. and Med.*, **74**, 838 (1950). Goldberg, R. G., Chaikoff, I. L., Dodge, A. H., *ibid.*, **74**, 869 (1950).

Acquired Resistance to Colchicine in a Strain of *Trichomonas vaginalis*

Trichomonas vaginalis Donné, 1837 can be made resistant to a variety of chemical compounds and is a suitable organism for the study of resistance, particularly as it can be maintained indefinitely in bacteria-free cultures. Moreover, it possesses a cytostome and ingests relatively large granules (for example, rice starch), and probably acquired resistance in the case of this flagellate does not depend on non-transit of a particular compound through the surface membrane as is apparently the case in resistant trypanosomes. Thus a strain of *T. vaginalis* was made resistant to 4.4′-diamidino stilbene. Initially the strain tolerated not more than 1 in 70,000; but by culturing repeatedly on gradually increasing concentrations, a strain was obtained which grew in a concentration of 1 in 5,000. 4.4′-Diamidino stilbene fluoresces in ultra-violet light, and it was easy to demonstrate its presence in the cytoplasm of resistant flagellates grown on a concentration of 1 in 5,000[1]. On the other hand, we failed to make an Indian strain of *Leishmania donovani* and a Sudan strain of *L. infantum* resistant to this drug by the usual method of subculturing in gradually increasing concentrations.

In view of the well-known effect of colchicine on mitosis, it was considered interesting to attempt to make *T. vaginalis* resistant to colchicine. Initially our strain grew in a concentration of 1 in 16,000 colchicine incorporated in the medium, but there were only a few survivors in flagellates inoculated into medium containing 1 in 11,000. After culturing on gradually increasing concentrations for a period of almost twenty-six months (September 9, 1949–November 22, 1951) a strain was obtained which has grown on a concentration of 1 in 600 during the last four months (in thirty-two passages).

During this work a number of strains, after having been established on particular concentrations, were maintained on colchicine-free medium for various periods and were then tested to determine whether they still maintained their resistance. The results were as follows:

Four strains were made resistant respectively to 1 in 3,000 (first grown on December 27, 1950, and maintained on this concentration for forty-five passages until May 17, 1951), to 1 in 2,000 (first grown on February 18, 1951, and maintained on this concentration for twenty-four passages until May 17, 1951), to 1 in 1,600 (first grown on May 11, 1951, and maintained on this concentration for only two passages until May 17, 1951), to 1 in 1,300 (first grown on June 6, 1951, and maintained on this concentration for twenty-seven passages until September 24, 1951), and were all kept on colchicine-free medium after the second of the above indicated dates.

On February 7, 1952, after the first three of the above strains had been grown for almost nine months (seventy passages) and the fourth for four and a half months (thirty-six passages) on normal medium, they were tested on their respective concentrations of colchicine and all gave rich normal cultures.

In the early passages, after transition from a lower to a higher concentration, cultures contained, apart from normal flagellates, large round multinuclear forms about 30 μ in diameter (these forms occur rarely in normal cultures); but in further passages the flagellates appeared normal in every respect. The temporary appearance of large round multinuclear forms in considerable numbers during the process of

selecting resistant strains by subjecting *T. vaginalis* to progressively increasing concentrations is not peculiar to colchicine, for it also occurs in similar circumstances in the case of 4.4′-diamidino stilbene.

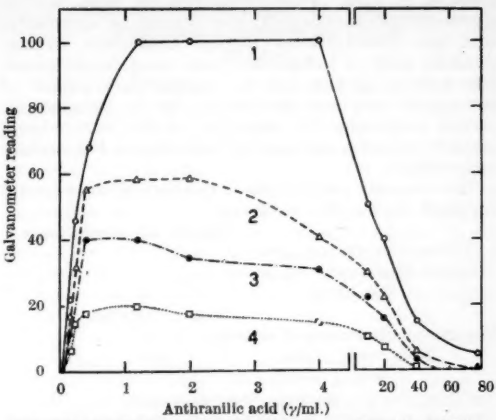
The above observations show that a strain of *T. vaginalis* was made resistant to concentrations of colchicine far beyond the maximum tolerated original dose, and that the resistance persisted after a considerable period of growth on colchicine-free medium.

We have to thank Dr. Anna Weizmann, of the Weizmann Institute, Rehovot, for preparations of pure colchicine from *Colchicum hierosolymitanum* Feinbr.

S. Adler
A. Back
A. Sadovsky

Department of Parasitology,
Hebrew University,
Jerusalem.
May 7.

[1] Adler, S., Sadovsky, A., and Bichovsky, L., *Harefuah*, **32**, No. 2, 55 (1947).



Reversal of chloramphenicol inhibition by anthranilic acid in *E. coli* mutant requiring anthranilic acid. Incubated: 18 hr. at 37°. Curve 1: no chloramphenicol; curves 2, 3, 4: 1·2, 1·6 and 2·0 γ/ml. of chloramphenicol, respectively

Mode of Action of Chloramphenicol

According to Woolley[1], chloramphenicol inhibits the utilization of phenylalanine in *E. coli*, due to its structural resemblance to that amino-acid. Truhaut, Lambin and Boyer[2], on the other hand, have concluded from experiments with *E. typhi* that the antibiotic interferes in the early stages of the synthesis of tryptophane, which Fildes[3] has formulated as follows:

anthranilic acid → indole
indole + serine → tryptophane.

In an attempt to elucidate the mode of action of chloramphenicol, its effect on *E. coli*, wild type, and on a number of its mutants, has been investigated. The inhibition caused in *E. coli*, wild type, can be fully reversed by indole and DL-tryptophane, less easily by DL-phenylalanine and L-tyrosine; it is not reversed by anthranilic acid. This result tends to show that chloramphenicol interferes with the synthesis of indole from anthranilic acid. The study of the mutants of *E. coli* clarifies the point still further.

In the anthranilic acid mutant (121–35), small quantities of anthranilic acid reverse the inhibition caused by chloramphenicol (up to 60 per cent of full growth), whereas larger doses inhibit growth (see graph). In the indole mutant (19–2), the inhibition is reversed by indole. In the tryptophane (19–2), phenylalanine (*M*83–5) and tyrosine (83–9) mutants, the inhibition is only reversed by the respective amino-acids if it is caused by low concentrations of chloramphenicol (1·2 γ/ml.).

The completeness of the reversal effects decreases from the indole mutant to the tyrosine mutant; this, incidentally, appears to point to a scheme for the interrelationship of the three aromatic amino-acids in which phenylalanine and—still more—tyrosine are further removed from the point of the attack of the antibiotic than tryptophane, that is:

precursor → tryptophane → phenylalanine → tyrosine[4].

The question of the mechanism by which indole is synthetized from anthranilic acid does not seem to have been investigated. The hypothesis that N-formylanthranilic acid is the intermediate product has been tested in view of previous experience with 4-formamido-imidazole-5-carboxamide[5] and of the observations of Knox and Mehler[6] on the transformation of tryptophane into kynurenine via formylkynurenine; however, N-formylanthranilic acid was inactive. In *E. coli*, wild type, the inhibition by chloramphenicol is overcome by the combination of anthranilic acid with methionine and vitamin B_{12} (see table). Folic acid was inactive, and *p*-amino-benzoic acid showed a negligible activity, when used in conjunction with anthranilic acid and methionine. All other—normal—'methyl donors' were completely ineffective, only histidine showing a very slight activity.

Analogously, the inhibition caused by chloramphenicol in the anthranilic acid mutant could be reversed by the addition of vitamin B_{12} or methionine, or the system vitamin B_{12} plus homocystein; the latter alone proved completely ineffective.

The methyl group of methionine has also been found to be the sole source of a 'lone' carbon atom in the biosynthesis of purines[7] and in the biosynthesis of nicotine in the tobacco plant[8].

The observation that larger quantities of anthranilic acid inhibit the growth of the mutant requiring anthranilic acid suggests that this amino-acid is not the immediate precursor of indole. The

Reversal of Chloramphenicol Inhibition in *E. coli*, Wild Type
(*Materials added:* Anthranilic acid, 4 γ/ml.; vitamin B_{12}, 0·0004 γ/ml.; DL-methionine, 12 γ/ml.)

Chloramphenicol (γ/ml.)	Per cent of full growth	Anthranilic acid	Vitamin B_{12}	DL-Methionine	Vitamin B_{12} + anthranilic acid	Vitamin B_{12} + DL-methionine	DL-Methionine + anthranilic acid	Vitamin B_{12} + DL-methionine + anthranilic acid
2·8	15	17	18	21	17	22	20	27
2·4	33	34	42	47	41	56	52	60
2·0	45	45	52	65	50	70	73	75
1·6	50	51	55	63	54	68	68	74
1·2	70	69	71	71	75	73	72	75

possibilities that N-methyl-anthranilic acid, an N-glycosido-anthranilic acid, or a peptide of anthranilic acid are intermediates in the conversion of anthranilic acid to indole, are now being investigated. The ability of the cell to synthetize peptides of anthranilic acid is demonstrated by the structure of certain alkaloids, for example, of the antimalarial alkaloid in *Hydrangea*[9] and of delsemin in *Delphinium oreophilum*[10].

The mutants used in this investigation were kindly supplied by Dr. B. D. Davis.

Ernst D. Bergmann

Scientific Department,
Israeli Ministry of Defence,
Tel-Aviv.

Sarah Sicher

Weizmann Institute of Science,
Rehovoth, Israel.

May 17.

[1] Woolley, D. W., *J. Biol. Chem.*, **185**, 293 (1950).
[2] Truhaut, R., Lambin, S., and Boyer, M., *Bull. Soc. Chim. Biol.*, **33**, 387 (1951).
[3] Fildes, P., *Brit. J. Exp. Path.*, **21**, 315 (1940); **22**, 293 (1941); **26**, 416 (1945).
[4] Bergmann, E. D., Volcani, B. E., and Sicher, S. (unpublished results).
[5] Ben-Ishai, R., Volcani, B. E., and Bergmann, E. D., *Arch. Biochem. Biophys.*, **32**, 229 (1951). Bergmann, E. D., Ben-Ishai, R., and Volcani, B. E., *J. Biol. Chem.*, **194**, 531 (1952).
[6] Knox, W. E., and Mehler, A. H., *J. Biol. Chem.*, **187**, 419, 431 (1950).
[7] Ben-Ishai, R., Volcani, B. E., and Bergmann, E. D., *Experientia*, **7**, 63 (1951). Bergmann, E. D., Volcani, B. E., and Ben-Ishai, R., *J. Biol. Chem.*, **194**, 521 (1952).
[8] Brown, S. A., and Byerrum, R. U., *J. Amer. Chem. Soc.*, **74**, 1523 (1952).
[9] Ablondi, F., Gordon, S., Morton, jun., S., and Williams, J. H., *J. Org. Chem.*, **17**, 14 (1952), and following papers.
[10] Yunusow, S., and Abutakirov, N. K., *Chem. Abstr.*, **46**, 516 (1952).

Hypotensive Alkaloids of *Veratrum album*

Investigations on alkaloids of *Veratrum viride* necessitated the preparation of a pure specimen of protoveratrine and prompted an examination of the alkaloids which could be isolated from commercial samples of *Veratrum album*. As a result of these studies, we now report the isolation of two new hypotensive ester alkaloids which have been named 'germitetrine' and 'veratetrine'.

Extraction of commercial *Veratrum album* and crystallization of the crude product from ether according to the method described by W. A. Jacobs and L. C. Craig[1] yielded a crystalline fraction which was subjected, without further purification, to a 24-plate Craig counter-current distribution, using benzene and 2 *M* acetate buffer at *p*H 5·5 as the immiscible phases.

From tubes 17–24 of the above Craig distribution, protoveratrine was isolated (m.p. 270–271° with decomp. (cor.); $[\alpha]_D^{25}$, − 35·9° (con. 1·0 in pyridine); $[\alpha]_D^{25}$, − 10·9° (con. 1·0 in chloroform); calculated for $C_{36}H_{61}O_{13}N$; C, 62·28; H, 8·18; found: C, 61·70; H, 7·78 per cent). The material was further identified as protoveratrine by degradation studies. Hydrolysis at room temperature in presence of methanolic sodium hydroxide yielded the alkamine isoprotoverine (isolated and characterized by melting point, analysis and ultra-violet absorption spectrum) and an acidic fraction. The acidic fraction was treated with *p*-phenyl phenacyl bromide, and the resulting mixture separated chromatographically into the *p*-phenyl phenacyl esters of acetic acid, α-methyl butyric acid and methyl ethyl glycollic acid, using methods similar to those described by J. Fried, H. L. White and D. Wintersteiner[2].

The material recovered from tubes 10–15 was crystallized from benzene and yielded germitetrine (m.p. 229–230°; $[\alpha]_D^{25}$, − 74° (con. 1·0 in pyridine); $[\alpha]_D^{25}$, − 12° (con. 1·0 in chloroform)). Analytical data indicate the empirical formula $C_{41}H_{63}O_{14}N$; (calculated, C, 62·00; H, 7·92; N, 1·80; found: C, 62·01, 61·88; H, 7·89, 7·77; N, 1·37, 1·37 per cent); calculated equivalent weight, 794; found, 780. Germitetrine has a characteristic infra-red spectrum which differs from the spectra of protoveratrine and veratetrine. Alkaline hydrolysis of germitetrine and examination of the hydrolysis products by the methods indicated above has yielded the alkamine germine, together with the *p*-phenyl phenacyl esters of acetic acid, α-methyl butyric acid and a third unidentified acid. The *p*-phenyl phenacyl ester of the unidentified acid crystallized from ethanol in white needles (m.p. 163–164° (cor.)). Volatile acid determinations gave 2·8–3·02 equivalent of volatile acid and would indicate that the unidentified acid is non-volatile, since other evidence suggests that germitetrine is a tetra-ester containing two moles of acetic acid, one mole of α-methyl butyric acid and one mole of unidentified acid in combination with one mole of the alkamine germine.

From tubes 0–9 of the Craig distribution, veratetrine was isolated (m.p. 269–270° (dec.); $[\alpha]_D^{25}$, − 32° (con. 1·0 in pyridine); $[\alpha]_D^{27}$, − 6·8° (con. 2·0 in chloroform). The analytical data indicate the empirical formula $C_{43}H_{64}O_{16}N$; (calculated, C, 60·7; H, 7·58; N, 1·6; equiv. weight, 850·5; found, C, 60·1; H, 7·50; N, 1·4 per cent; equiv. weight, 839). Alkaline hydrolysis of veratetrine and examination of the hydrolysis products by the usual methods has afforded isoprotoverine and the *p*-phenyl phenacyl esters of α-methyl butyric acid, acetic acid and an unidentified acid.

This work will be described in greater detail in a forthcoming publication.

William L. Glen
Gordon S. Myers
Richard Barber
Paul Morozovitch
Gordon A. Grant

Research and Biological Laboratories,
Messrs. Ayerst, McKenna and Harrison, Ltd.,
Montreal.

July 4.

[1] *J. Biol. Chem.*, **143**, 427 (1942).
[2] *J. Amer. Chem. Soc.*, **72**, 4621 (1950).

Transport of Substances through the Tentacles of Leaves of *Drosera capensis* L.

It was found by Darwin[1] that the tentacles of *Drosera* secrete a viscous liquid with their glands, that they curve after stimulation and that they absorb substances from the animals caught. The processes of uptake and transport have been extensively studied in my laboratory[2,4,5]. The marginal tentacles of a cut leaf are put between strips of agar which contain the substance to be absorbed. The tentacles translocate it in their pedicels to the leaf. The curving of the tentacles which would move them out of the agar can be prevented by adding an osmotic substance (sugar or salt) to the agar. This reduces the turgor of the tentacles so that they cannot curve.

The uptake of different substances was determined with simple methods: phosphate colorimetrically and nitrogen by micro-Kjeldahl method. The uptake

of all substances depends more or less on the presence of oxygen. The results given here relate only to a class of actively absorbed substances, by which we understand that in the absence of oxygen no absorption takes place at all (this is only valid in sufficiently low concentrations).

Two groups of actively absorbed substances have been investigated: (1) inorganic phosphates; (2) amino-acids (asparagine and glutamine). The substances are only absorbed at low concentrations. A maximum level of uptake is attained at a rather low concentration. Experiments with simultaneous uptake of two substances show that, if substances of the same group are combined, summation results until the maximum level of uptake for that group is attained. If substances belonging to different groups are combined, the summation goes on until the maximum level is attained for each substance. This indicates that in the uptake of the two groups of substances different metabolic processes are involved.

These results have been confirmed by new observations with enzyme inhibitors. The inhibiting substances were applied in the agar which contained the transport substance. Substances inhibiting respiration (cyanide, azide, iodoacetate and arsenite) diminish the uptake of substances of both groups. Likewise, 2-4 dinitrophenol has an unspecific inhibitory function (Table 1). Some inhibitors were found to be more specific. For example, phloridzin inhibits the transport of phosphate but not that of asparagine, whereas penicillin inhibits the transport of asparagine but not that of phosphate (Table 2). The specific action is in good agreement with the assumption that the absorption of phosphates depends on different metabolic processes from that of amino-acids, but both depend on respiration.

EFFECT OF INHIBITORS ON THE UPTAKE OF ASPARAGINE AND PHOSPHATE BY THE TENTACLES OF *Drosera* LEAVES, IN PARTS PER 1,000 PARTS OF FRESH WEIGHT OF THE LEAVES

1. Non-specific inhibitor (2-4 dinitrophenol)

	24-hr. uptake of 1/100 *M* asparagine (nitrogen)	24-hr. uptake of 1/80 *M* pot. dihydrogen phosphate (phosphate)
Without inhibitor	1·06	0·50
2-4 Dinitrophenol 10^{-7} *M*	0·74	0·40
2-4 Dinitrophenol 10^{-6} *M*	0·19	0·07
2-4 Dinitrophenol 10^{-5} *M*	−0·01	−0·07

(2) Specific inhibitor (penicillin)

	24-hr. uptake of 1/100 *M* asparagine (nitrogen)	48-hr. uptake of 1/200 *M* pot. dihydrogen phosphate (phosphate)
Without inhibitor	1·35	0·75
Penicillin, 1 O.U./ml.	1·16	0·75
Penicillin, 2 O.U./ml.	0·74	0·77
Penicillin, 4 O.U./ml.	0·58	0·76

The specific action of penicillin on amino-acid uptake by *Drosera* tentacles reminds us of the inhibition investigated by Gale of the uptake of glutamic acid in growing cells of *Staphylococcus aureus*[3].

W. H. ARISZ

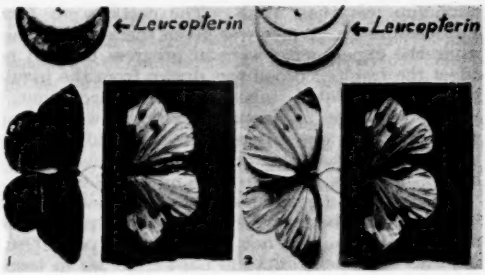
Botanical Institute,
Groningen.
July 20.

[1] Darwin, C., "Insectivorous Plants" (John Murray, London, 1875.)
[2] Arisz, W. H., *Proc. Ned. Akad. Wet.*, **45**, 2 and 794 (1942); *Verslagen Ned. Akad. Wet., afd. Nat.*, **53**, 236 (1944) (Dutch).
[3] Gale, E. F., *Bull. Johns Hopkins Hosp.*, **83**, 119 (1948).
[4] Arisz, W. H., "Ann. Rev. Plant Physiol.", **3**, 109 (1952).
[5] Arisz, W. H., and Oudman, J. *Proc. Kon. Ned. Akad. Wet.*, **40**, 431 (1937).

Sex in *Pieris rapæ* L. and the Pteridin Content of their Wings

WHEN *Pieris rapæ* L. was photographed under the illumination of ultra-violet light passing through the filter *UV-D*1 obtained from the Matsuda Lamp Co., the wings of female butterflies, in accordance with the description of Frank Lutz[1], showed a white image, for they reflected the light, whereas those of male butterflies gave a black shadow because they absorbed the ultra-violet light strongly, as seen in the accompanying photograph (Fig. 1); this is in striking contrast to photographs taken in daylight (Fig. 2). Experiments carried out to elucidate the mechanism of this phenomenon showed that it is due to the difference of pterin content between the male and the female wings.

Under ultra-violet light passing through the filter *UV-D*1, the male insects showed an intense dark vermilion fluorescence, whereas the female wings gave only a very faint pale fluorescence.



When an aqueous suspension of a small quantity of powdered leucopterin was filtered through a small filter paper and the residue with the filter paper was photographed under the illumination of ultra-violet light, it showed the same black shadow as that of the male wings (see Fig. 1). The leucopterin had under ultra-violet light the same vermilion fluorescence as the male wings.

A chemical analysis of the wings of *Pieris rapæ* L. was then carried out. Equal numbers of the wings of female and male insects, after washing with ether, alcohol and then with water, were extracted with dilute ammonia. The extracts were then evaporated to a small volume, when two kinds of white deposits settled out from the extract of male wings, while a very small amount of precipitate was found in the case of the female wings only after concentration to a very small volume. The first precipitate from the extract of male wings was identified as a mixture of eucopterin with a small quantity of uric acid by comparison with the synthetic samples on paper chromatography[2], and by ultra-violet absorption spectra, while the second (a small quantity) consisted of uric acid and xanthopterin *a* [2]. The precipitate extracted from the female wings consisted of xanthopterin *b*, which was identified by its R_F and a deep purple fluorescence under ultra-violet light on paper chromatography[2].

The filtrates of the above precipitates showed on paper chromatography in the case of male wings spots of leucopterin, xanthopterin *a* and a trace of xanthopterin, and in the case of female wings spots of xanthopterin *b* and a trace of xanthopterin.

Generally speaking, the pterin content of female wings is very small in contrast with that of male wings.

Katashi Makino
Kiyoo Satoh
Masahiko Koike
Naomichi Ueno

Department of Biological Chemistry,
Kumamoto University Medical College,
Japan.
July 25.

[1] Cf. Yagi, *Shizen* (Japanese), **7**, No. 1, 69 (1952).
[2] Good and Johnson, *Nature*, **163**, 31 (1949).

Diurnal Variations in the Blood Picture of Cattle

Cattle bloods were examined at intervals during the course of the day at Kabete, Kenya, altitude 6,300 ft., the maximum temperature at the season of the experiment being greater than 75° F., the minimum less than 52° F. The cattle were Zebu/European cross. Water was given them at one point while the experiments were in progress but did not affect the results. Blood was drawn from the jugular vein into oxalated tubes, prepared according to Wintrobe[1]. The neck was constricted with a rope while the vein was entered, but released while the blood sample was being drawn. Blood was drawn at hourly intervals between 9·0 a.m. and 3.0 p.m.

Hæmoglobin figures (estimated by Sahli) varied little and may be regarded as usually constant. The normal variation did not exceed 1 gm. per 100 c.c.

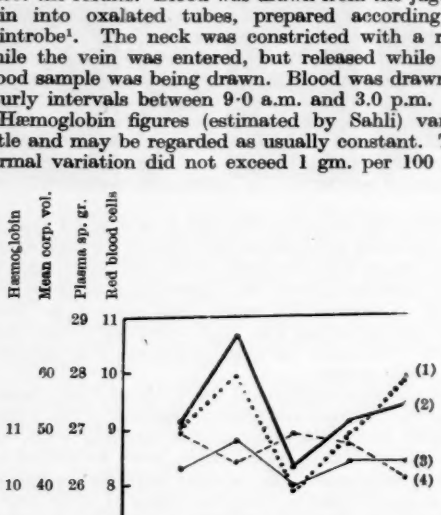


Fig. 1. No. 3237. (1) Specific gravity of plasma; (2) red blood cells (millions/c.mm.); (3) hæmoglobin (gm./100 c.c.); (4) mean corpuscular volume (c.μ)

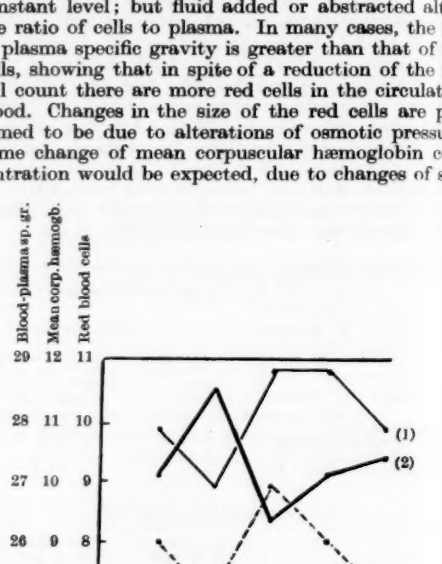


Fig. 2. No. 3237. (1) Mean corpuscular hæmoglobin ($\gamma\gamma$); (2) red blood cells (millions/c.mm.); (3) difference between specific gravity of blood and plasma

The red-cell count varied over two million on initial counts of seven million to ten million. Maximum variations of the packed cell volume occurred of 6 per cent (that is, per cent red cells of whole blood) on initial figures of 37–48 per cent; mean corpuscular volume showed variations in most cases, the greatest change being from 47 to 59 c.μ. Mean corpuscular hæmoglobin showed variations of as much as 3 $\gamma\gamma$ on initial readings of 12 $\gamma\gamma$ and mean corpuscular hæmoglobin concentration of 3 per cent on initial figures of 21–27 per cent. Plasma specific gravity varied within wide limits, a fall from 1·028 to 1·025 being recorded. Blood specific gravity figures had no significance, owing to the changes of specific gravity of plasma; the difference between the specific gravity of the blood and plasma, however, showed wide variation.

Estimations of dry weight of plasma samples have shown that plasmas of high specific gravity contain a greater percentage of dry matter. The fall of specific gravity is therefore due to dilution of the plasma with fluid.

The following correlations were found: (1) between the red cell count and the specific gravity of the plasma; (2) inversely both between red blood cells and mean corpuscular hæmoglobin, and between packed cell volume and mean corpuscular hæmoglobin concentration; (3) between packed cell volume and the specific gravity of the plasma; (4) inversely between mean corpuscular volume and the specific gravity of the plasma; (5) the difference between blood and the specific gravity of the plasma is inversely related to the red cell count.

Some of these changes in the case of one animal studied are shown in the accompanying charts.

The key to these changes must lie with the variation of the specific gravity of the plasma. The hæmoglobin content of the blood is maintained at a constant level; but fluid added or abstracted alters the ratio of cells to plasma. In many cases, the fall of plasma specific gravity is greater than that of red cells, showing that in spite of a reduction of the red cell count there are more red cells in the circulating blood. Changes in the size of the red cells are presumed to be due to alterations of osmotic pressure. Some change of mean corpuscular hæmoglobin concentration would be expected, due to changes of size of red cells. Changes of mean corpuscular hæmoglobin, however, reveal a mechanism in which the quantity of hæmoglobin in the individual cell may be varied. The mean corpuscular hæmoglobin is in inverse proportion to the red cell count, but related to the difference between the specific gravity of the blood and plasma. It follows that the weight of the red cells is proportional to their hæmoglobin content.

The object of this work was achieved when the diurnal variations were demonstrated, and it will probably not be further pursued. It is evident that workers should not attach too much weight to variations in the blood picture of cattle under African con-

ditions. Other implications are involved, namely, the variation of the fluid content of the circulating blood. This may be due to the action of the liver on water metabolism, and reference may be made to Lichtman's work[2], who describes this effect.

It is possible that a study of the control of water metabolism, suggested by this work, may be of importance to an understanding of the physiology of cattle in hot climates or in times of drought.

R. N. T.-W.-Fiennes

East African Veterinary Research Organization,
Veterinary Research Laboratory,
P.O. Kabete, Kenya.
July 15.

[1] Wintrobe, P. Maxwell, "Clinical Hematology", 218 (London: Henry Kimpton, 1946).
[2] Lichtman, S. S., "Diseases of the Liver, Gall Bladder and Bile Ducts", 106 (London: Henry Kimpton, 1949).

Vapour-Liquid Equilibrium Relationships in Extractive Distillation

The advantages of using binary data to calculate the effect of a high-boiling solvent on the volatility of a pair of liquids have frequently been emphasized. Recently, a thermodynamic method of calculating the average value of the logarithm of the volatility ratio of the low-boiling pair (components 1 and 2) at a constant mole fraction of the high-boiling solvent (component 3) under isothermal conditions from binary data has been advanced[1]. A treatment of this type has now been developed for single liquid-phase systems under a pressure of one atmosphere and the following approximate expression obtained

$$[\log \bar{\alpha}_{12x_3}]_{x_3,\text{isobaric}} \approx 4{\cdot}559\ [\Delta T_{21} + (\Delta T_{23} - \Delta T_{13})/x_3']/T \qquad (1)$$

These terms have the following significance: $[\log \bar{\alpha}_{12x_3}]_{x_3'.\text{isobaric}}$ is the average value of the logarithm of the volatility ratio of component 1 with respect to component 2 at a constant mole fraction, x_3', of the high-boiling solvent taken from the composition $x_1 \to 0$ to $x_2 \to 0$ under isobaric conditions. Thus this quantity is defined by equation (2), where the integral on the right-hand side is to be taken for a pressure of one atmosphere and for a constant mole fraction, x_3', of component 3.

$$[\log \bar{\alpha}_{12x_3}]_{x_3,\text{isobaric}} = \left[\int_0^{1-x_3} \log \alpha_{12x_3} dx_1\right]/(1-x_3') \qquad (2)$$

ΔT_{21} is the normal boiling point of pure component 2 minus the normal boiling point of pure component 1, in degrees Celsius; ΔT_{23} is the normal boiling point of the mixture of components 2 and 3 containing a mole fraction x_3' of the extractive solvent 3, minus the normal boiling point of pure component 2, in degrees Celsius; ΔT_{13} is the normal boiling point of the mixture of components 1 and 3 containing a mole fraction x_3' of the extractive solvent 3, minus the normal boiling point of pure component 1, in degrees Celsius; T is the mean of the normal boiling points in degrees absolute of the mixtures (1,3) and (2,3) containing a mole fraction x_3' of component 3.

For many systems the value of $[\log \bar{\alpha}_{12x_3}]_{x_3'.\text{isobaric}}$ will be found to be nearly equal to that of the logarithm of the volatility ratio of component 1 with respect to component 2 in the mixture containing equal mole fractions of components 1 and 2 and a mole fraction x_3' of component 3.

Previously, it was shown[1] that for isothermal data the most satisfactory third component will, in general, be that material which yields the largest numerical value of the function $[\log \bar{\alpha}_{12x_3}' - \log \bar{\alpha}_{12}]$, where the pure substance 1 is the component with the highest vapour pressure and where $\log \bar{\alpha}_{12}$ is the average value of $\log \alpha_{12}$ for the binary (1,2). From expression (1) it follows that, subject to the approximations used, the most satisfactory third component at a given mole fraction x_3' is that material which gives the largest numerical value for the expression $(\Delta T_{23} - \Delta T_{13})/T$.

The derivation of expression (1) is based on a rigorous thermodynamic treatment, but it involves many additional assumptions, of which the following are some of the more important. The vapours have been assumed to behave as ideal gases and the molar volume of the liquids has been assumed to be negligible compared with that of the vapour. The vapour pressure of the extractive solvent has been assumed to be negligible at the normal boiling temperatures of the mixtures (1,3) and (2,3) containing a mole fraction x_3' of component 3. The activity coefficients in the binary (1,3) have been assumed to obey the relationships $\log \gamma_1 = C_1(x_3')^2$; $\log \gamma_3 = C_1(1-x_3')^2$, where C_1 is a constant. Equations of a similar type involving a constant C_2 have been assumed to be applicable to $\log \gamma_2$ and $\log \gamma_3$ in the mixture (2,3). A term on the right-hand side equal to $\left[\int_{T_{13}}^{T_{23}} (\Delta H/T^2)dT\right]/2{\cdot}303R(1 - x_3')$ has been neglected in the derivation of expression (1), where ΔH is the molar heat of mixing of the mixture containing x_1, x_2 and x_3' mole fractions of components 1, 2 and 3, and T_{13}, T_{23} are the normal boiling points on the absolute scale of mixtures (1,3) and (2,3) containing a mole fraction x_3' of component 3. The latent heats of vaporization of the pure components 1 and 2 and of these materials from the binary mixtures (1,3) and (2,3) have been assumed to satisfy Trouton's rule.

Application of expression (1) to the experimental results for seven systems and a total of nineteen concentrations of third component where the experimental values of $[\log \bar{\alpha}_{12x_3}]_{x_3'.\text{isobaric}}$ varied from 0·05 to 0·44 showed a standard deviation of 0·043 units between the calculated and observed figures. This value is equivalent to a deviation of approximately 10 per cent in the anti-logarithm of $[\log \bar{\alpha}_{12x_3}]_{x_3'.\text{isobaric}}$.

Although a considerable number of assumptions is made in the derivation of expression (1), and although this expression is only approximate, nevertheless it is thought that this relationship is sufficiently accurate for use in the preliminary selection of the most suitable solvent for the separation of a given binary (1,2). The small amount of experimental measurement required for use in expression (1) is an attractive feature of this treatment.

This work has been carried out as part of the programme of the Chemistry Research Board, and is published by permission of the Director, Chemical Research Laboratory.

E. F. G. Herington

Chemical Research Laboratory,
Teddington,
Middlesex.
April 25.

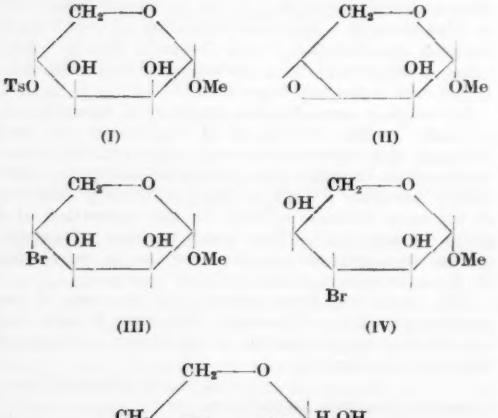
[1] Herington, *Research*, 3, 41 (1950)

4-Deoxy-L-Ribose

Recent investigations[1] of the behaviour of the Dische reagent[2] towards various deoxysugars and their glycosides have revealed that a coloration is obtained with a number of such compounds, and that the reagent cannot be regarded as specific for 2-deoxyribose. Colorimetric evidence based on the Dische test thus does not preclude the occurrence of deoxysugars other than 2-deoxy ribose[3] in the deoxypentose nucleic acid structure. As an extension to the investigations on the known 2-deoxyribose[4] and 3-deoxyribose[5] (otherwise known as 3-deoxyxylose), we have synthesized 4-deoxy-L-ribose, with a view to its characterization and the study of its behaviour towards colorimetric reagents.

3 : 4-Anhydro-α-methyl-D-lyxoside (II) was formed by treatment of 4-tosyl-α-methyl-D-lyxoside (I) with sodium methoxide. Scission of the ethylene oxide ring with hydrogen bromide in acetone was expected to yield two derivatives[6], 4-bromo-α-methyl-D-lyxoside (III) and 3-bromo-β-methyl-L-xyloside (IV), although, in fact, only the 4-bromo compound was isolated. Hydrogenation of the latter (III) in the presence of Raney nickel led to the glycoside of the required compound.

α-Methyl-lyxoside was shaken for 12 hr. with acetone containing concentrated sulphuric acid. After neutralization and removal of the solvent, 2 : 3-acetone-α-methyl-D-lyxoside was distilled as a viscous syrup (b.p. 65°/0·02 mm.; n_D^{23}, 1·4575). This compound reacted readily with *p*-toluenesulphonyl-chloride in pyridine to give crystalline 4-tosyl-2 : 3-acetone-α-methyl-D-lyxoside (m.p. 96–97°; $[\alpha]_D^{23}$, − 10·2° in ethanol (con., 1·85)). When warmed with dilute acetic acid the isopropylidene group was removed and 4-tosyl-α-methyl-D-lyxoside ($[\alpha]_D^{21}$, + 30·0° in chloroform (con., 1·4); n_D^{21}, 1·5140) resulted. Mild alkaline hydrolysis of this 4-tosyl derivative yielded 3 : 4-anhydro-α-methyl-D-lyxoside (b.p. 115° (bath temp.)/0·02 mm.; $[\alpha]_D^{23}$, + 98·6 in acetone (con., 1·4)). The anhydro ring was cleaved when this compound was boiled with hydrogen bromide in acetone for 4 hr., and crystalline 4-bromo-α-methyl-D-lyxoside (III) (m.p. 134–135°) was obtained. Evidence for the structure of this compound was obtained from its ready oxidation by lead tetra-acetate in glacial acetic acid[7]. Reduction of (III) with hydrogen in the presence of Raney nickel and calcium hydroxide at room temperature and atmospheric pressure gave 4-deoxy-β-methyl-L-riboside ($[\alpha]_D^{23}$, + 39° in water (con., 0·22)), which was hydrolysed by dilute aqueous acid to 4-deoxy-L-ribose (V) ($[\alpha]_D^{23}$, + 23 in water (con., 0·2); n_D^{23}, 1·4920) which gave a crystalline α-benzylphenyl hydrazone (m.p. 102–103°).



Comparative Dische tests[2] performed simultaneously on 2-, 3- and 4-deoxyribose revealed that no coloration was given by the 4-deoxy compound or by ribose itself.

The chromatographic R_G values[8] of the three deoxyriboses were determined in butanol (40 per cent), ethanol (10 per cent), water (50 per cent) on Whatman No. 1 paper giving the following figures: 2-deoxyribose, 0·50; 3-deoxyribose, 0·60; 4-deoxyribose, 0·53.

The structure of this 4-deoxy compound involves certain problems of nomenclature, since the penultimate carbon atom is, in this case, symmetrical. We propose, therefore, that the configuration of this type of compound be decided by reference to the ultimate *asymmetrical* carbon atom, and in this instance the compound is therefore named '4-deoxy-L-ribose'.

We wish to thank Sir Rudolph Peters for his interest in these investigations.

P. F. V. Ward
P. W. Kent

Biochemistry Department,
University of Oxford.
May 25.

[1] Allerton, R., Overend, W. G., and Stacey, M., *J. Chem. Soc.*, 255 (1952).
[2] Deriaz, R. E., *et al.*, *J. Chem. Soc.*, 1222 (1949).
[3] Levene, P. A., and Jacobs, W. A., *J. Biol. Chem.*, **12**, 411 (1912). Levene, P. A., *J. Biol. Chem.*, **48**, 119 (1921). Kent, P. W., *Nature*, **166**, 442 (1950).
[4] Meisenheimer, J., and Jung, H., *Ber.*, **60**, 1462 (1927). Deriaz, R. E., *et al.*, *J. Chem. Soc.*, 1879 (1949).
[5] Kent, P. W., Stacey, M., and Wiggins, L. F., *J. Chem. Soc.*, 1232 (1949).
[6] Peat, S., "Adv. Carbohyd. Chem.", **2**, 49 (Acad. Press, N.Y., 1946).
[7] Hockett, R., and McClenahan, W. S., *J. Amer. Chem. Soc.*, **61**, 1667 (1939).
[8] Jones, J. N. K., *et al.*, *J. Chem. Soc.*, 930 (1949).

Modified Newtonian Systems

To the usual assumptions for Newtonian mechanics, we add the following, in order to account for the behaviour of light:

(1) The speed of light is the same in all directions, relative to the emitting source.

(2) If a source moves with constant velocity, relative to a Newtonian origin, the speed of light emitted along the line of motion is the same relative to the origin or the source.

From these two additional assumptions, it is possible to develop transformation equations for two Newtonian frames S and S'. We take V as the velocity of S' relative to S and c the speed of light relative to an emitting source considered fixed in S'. If accented co-ordinates are referred to S' and unaccented to S, we have the following equations

$$\alpha x' = x - Vt, \quad y = y', \quad z = z', \quad \alpha t' = t - Vx/c^2,$$

where

$$\alpha(V)\,\alpha\,(-V) = 1 - V^2/c^2.$$

The simplest values of α are $(1 + V/c)$, $(1 - V/c)$ and $(1 - V^2/c^2)^{1/2}$. The Lorentz–Einstein relative velocity formula is independent of α, and so experiments which are interpreted on this formula cannot be used to choose a suitable value of α. As a preliminary, however, phenomena requiring simple kinematics have been treated. A direct explanation of the Doppler effect gives $\alpha = 1 \pm V/c$ rather than $(1 - V^2/c^2)^{1/2}$.

With this value for α the formula for stellar aberration is derived. Instead of the usual $\sin \ell\theta = \frac{V}{c} \sin \theta$, it is found that

$$\sin \ell\theta = \frac{V}{c} \sin \theta\,(1 + \cos \theta).$$

There is a large discrepancy in these formulæ when θ is near $\pi/3$, and it is suggested that an experimental check should be made.

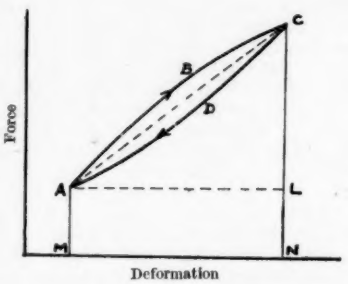
The transformation equations can be generalized without much difficulty and give at once the general Doppler formula.

R. Capildeo

University College,
London, W.C.1.
May 26.

Hysteresis in Rubber

In the discussion following a recent series of lectures given in the University of Nottingham on the dynamic properties of rubber, it became evident that the methods of specifying and measuring the amount of hysteresis in rubber are subjects of controversy. Two terms in current use for specifying hysteresis are 'percentage damping' and 'resilience', as defined in the accompanying diagram.



$$\text{Percentage damping} = \frac{\text{area } ABCD}{\text{area } ABCL} \times 100$$

$$\text{Resilience} = \frac{\text{area } ADCNM}{\text{area } ABCNM} \times 100$$

Resilience is thus the ratio of energy output to energy input during one complete cycle, but the physical significance of the term percentage damping is more obscure. The two terms are complementary only if the loop starts from zero strain. Resilience is generally measured by means of a rebound pendulum in which the cycle starts from zero strain, and as a result resilience and percentage damping are almost universally considered to be complementary. It should be stressed, therefore, that when a cycle is superimposed on a static strain, the terms are no longer complementary. Such cycles can be recorded on a Roelig machine[1] and also on the machine in use at this University, details of which are in course of publication. Investigations carried out with this machine show that the hysteresis loop changes in slope and area as the static strain is varied. This means that resilience at zero static strain cannot be converted to resilience at some finite static strain simply by including an additional area such as *ALNM*. Resilience or percentage damping must therefore be measured under the conditions in which the rubber is to be used.

It has also been found that resilience is very much a function of both frequency and amplitude. The latter result means that the use of a rebound pendulum to measure resilience is fundamentally unsound, though the figure obtained from such an instrument may not be much in error.

As to the relative merits of the two terms resilience and percentage damping, the former gives a figure of considerable practical importance, and is therefore likely to appeal to the rubber user. One unfortunate feature, however, is that the rubber technologist has given the term resilience a meaning different from that given by engineers. The latter consider resilience as the energy stored in a material in the strained state.

For comparing the mechanical behaviour of two rubbers, or of one rubber under different conditions, the term percentage damping is better, since it will reveal small differences which would be masked by using resilience. That is, a small change in the area of the hysteresis loop results in a much smaller percentage change in resilience than in the term percentage damping. It should be stressed, however, that the term percentage damping as defined by Roelig[2] is the ratio of the area of the loop to the area *ABCL* and not to the area of the triangle *ACL*. Roelig, in his earlier paper[1], used the area of the triangle, and many investigators since have followed this practice. The use of the triangle has several drawbacks and can lead to much ambiguity when the ends of the loops are very rounded or when the major axis of the loop is curved.

D. M. Davies

Engineering Department,
University of Nottingham.
May 12.

[1] Roelig, H., Proc. Rubber Tech. Conf., 821 (1938).
[2] Roelig, H., *Rubber Chem. and Tech.*, **18**, 62 (1945).

'Detectivity': the Reciprocal of Noise Equivalent Input of Radiation

There is a perfectly sound and well-known way of stating the ability of a radiation detector to detect weak signals. One simply states the amount of input radiation that produces a steady electrical output equal to the root-mean-square noise voltage, under conditions of measurement that are stated adequately. But unfortunately the noise equivalent input suffers from a crippling psychological defect: it is upside down—the better detector has a lower noise equivalent input.

Because of this psychological defect, one frequently hears the relative performance of detectors described by a statement such as: 'Detector *A* has a better signal-to-noise ratio than detector *B*'. This use of

the signal-to-noise concept involves, of course, a logical confusion. The signal-to-noise ratio is a combined property of a detector and a signal, whereas the intent of the above sentence was to describe a property pertaining only to the detector.

To this difficulty there is one solution, and I believe only one solution, which is sound both psychologically and logically. The solution is to introduce as an independent concept the reciprocal of the noise-equivalent radiation input, and to give this concept a name. For some time now I have been using the name 'detectivity' for the reciprocal of the noise equivalent input, and I now propose this term for general use. With this concept the sentence discussed above becomes simply, 'Detector *A* has more detectivity than detector *B*'.

The need for this concept was set forth in an unpublished report dated March 18, 1950; in the report I suggested the terms 'detectity' or 'recinepity' for the concept and asked for better suggestions. In a reply dated July 20, 1950, Dr. Peter B. Fellgett suggested the term 'detectivity', which I now prefer. 'Detectivity' is a very appropriate name for this concept. It is self-descriptive, and it matches the companion terms 'sensitivity' and 'responsivity'; it is translated easily into other languages. The primary disadvantage is that it uses as basis the word 'detective', which is usually employed with another significance.

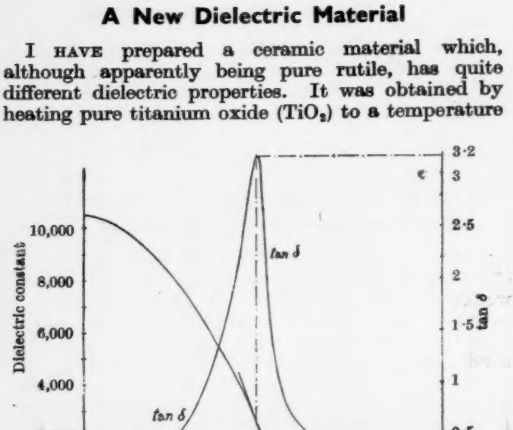
In summary, a need exists for a simple method of describing that property of a radiation detector which is greater for the detector that achieves a greater signal-to-noise ratio on a given radiation signal. Both the concept and a name for the concept have been lacking heretofore. 'Detectivity' is suggested as the name for the concept, and the detectivity is defined as the reciprocal of the noise equivalent input of a detector.

R. Clark Jones

Polaroid Corporation,
730 Main Street,
Cambridge 39, Mass.
May 6.

A New Dielectric Material

I have prepared a ceramic material which, although apparently being pure rutile, has quite different dielectric properties. It was obtained by heating pure titanium oxide (TiO_2) to a temperature of 1,400° C., as described elsewhere[1]. X-ray analysis leads to the same Debye–Scherrer pattern as rutile (axis ratio 1 : 0·911). The frequency dependence of the dielectric constant and of tan θ (θ = loss angle) of this substance is shown in the accompanying graph, measured at the Centre d'études des Télécommunications, Paris, by courtesy of the director, M. Caye. This substance thus exhibits a Debye type of loss connected with a very high static dielectric constant.



L. Nicolini

Department of Engineering,
Institute of Industrial and Applied Chemistry,
University of Bologna.
Aug. 29.

[1] Italian Patent 7592, Aug. 9, 1951.

Zoological Nomenclature

As from March 1, 1953, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of its plenary powers for the purposes specified in brackets against each entry. Full particulars of these cases were published on August 29, 1952, in the *Bulletin of Zoological Nomenclature*, those relating to cases (1) to (4) in Part 10 and those relating to cases (5) to (14) in Part 11 of Vol. 6.

(1) *Sphinx* Linnæus, 1758 (Cl. Insecta, Ord. Lepidoptera) (designation of type species); (2) Houttuyn (M.H.), 1787, *Animalium Musei Houttuinensi Index* (suppression); (3) *Phalæna* Linnæus, 1758 (Cl. Insecta, Ord. Lepidoptera) (suppression, and validation as of generic status of eight terms used by Linnæus for groups thereof: *Bombyx*, *Noctua*, *Geometra*, *Tortrix*, *Pyralis*, *Tinea*, *Alucita*, as from 1758, *Attacus*, as from 1767; and names of families based thereon; alternatively, for *Bombyx* and *Pyralis* (as from Fabricius, 1775) (designation of type species); (4) *Episema* Ochsenheimer, 1816 (Cl. Insecta, Ord. Lepidoptera) (designation of type species, thereby also preserving *Diloba* Boisduval, 1840); (5) *cydippe* Linnæus, 1761, *Papilio*, and *adippe* Linnæus, 1767, *Papilio* (Cl. Insecta, Ord. Lepidoptera) (suppression, and validation of *adippe* Denis and Schiffermüller, 1775, *Papilio*); (6) *hispidus* Olivier, 1811, *Palæmon* (Cl. Crustacea, Ord. Decapoda) (validation); (7) *Sicyonia* Milne Edwards, 1830 (Cl. Crustacea, Ord. Decapoda) (validation); (8) *Hymenocera* Latreille, 1819 (Cl. Crustacea, Order Decapoda) (designation of type species); (9) *Pyramidella* Lamarck, 1799 (Cl. Gastropoda, Sub-Cl. Prosobranchia) (validation, by suppression of *Plotia* Roeding, 1798); (10) *Dasypeltis* Wagler, 1830 (Cl. Reptilia) (validation); (11) *Trichopsylla* Kolenati, 1863 (Cl. Insecta, Ord. Siphonaptera) (suppression); (12) *pungens* Walcknaer, 1802, *Pulex*, and *vespertilionis* Dugès, 1832, *Pulex* (Cl. Insecta, Ord. Siphonaptera) (suppression); (13) *simus* Linnæus, 1767, *Coluber* (Cl. Reptilia) (determination of application); (14) *Mellita* Agassiz, 1841 (Cl. Echinoidea) (validation).

Comments on the above cases should be sent to me as soon as possible.

Francis Hemming
(Secretary to the International Commission on Zoological Nomenclature).
28 Park Village East,
Regent's Park,
London, N.W.1.
Aug. 29.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 1

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Anniversary Meeting.

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. G. de Q. Robin and Mr. J. J. Holtzscherer: "Depth of Polar Ice Caps".

SOCIETY OF ENGINEERS (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. B. R. Byrne: "The Fatigue of Metals—Facts and Theories Reviewed".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the FINE CHEMICALS GROUP and the LONDON AND SOUTH-EASTERN COUNTIES SECTION of the ROYAL INSTITUTE OF CHEMISTRY, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. G. E. Smith: "Essential Oils".

Tuesday, December 2

SCHOOL OF PHARMACY, University of London (in the Meyerstein Lecture Theatre, Westminster Hospital Medical School, Horseferry Road, London, S.W.1), at 5.30 p.m.—Sir Eric Rideal, F.R.S.: "Adsorption and Reaction in Monolayers and some Biological Implications".*

Wednesday, December 3

ROYAL SANITARY INSTITUTE (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Discussion on "Investigations into Swimming Bath Water Treatment" (to be opened by Dr. S. G. Burgess, Mr. D. Burns and Mr. C. W. Tidy).

PHYSICAL SOCIETY, COLOUR GROUP (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 3.30 p.m.—Mr. Oliver Cox: "The Architectural Use of Colour in Schools".

ROYAL SOCIETY OF MEDICINE, SURGERY SECTION (at 1 Wimpole Street, London, W.1), at 5 p.m.—Discussion on "The Use of Radio-Isotopes in Surgery".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. D. A. Wright: "A Survey of Present Knowledge of Thermionic Emitters".

UNIVERSITY OF LONDON (in the Senate House, Malet Street, London, W.C.1), at 5.30 p.m.—Prof. M. Born, F.R.S.: "Research in Theoretical Physics by the Department of Mathematical Physics, Edinburgh".* (Further Lectures on December 5 and 10.)

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, POLAROGRAPHIC DISCUSSION PANEL of the PHYSICAL METHODS GROUP (at Sir John Cass College, Jewry Street, London, E.C.3), at 6.30 p.m.—Annual General Meeting; Mr. P. R. D. Pomeroy and Mr. R. A. White: "Modification of the Cambridge Polarograph for Derivative Polarography"; Dr. W. Stross: "The Polarographic Determination of Cadmium in Aluminium and some other Alloys".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Dr. H. H. Green: "Industrial Fluorosis".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Scientific Films: "The Chameleon" (English), "Marvels in Miniature" (Australian), "L'Hippocampe" (French), "Cardiac Output in Man" (introduced by Prof. J. McMichael).

Wednesday, December 3—Friday, December 5

EUROPEAN ASSOCIATION OF EXPLORATION GEOPHYSICISTS (at the Stadthalle, Corvinusplatz 2, Hanover, Germany).—Third Meeting.

Thursday, December 4

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. H. E. M. Barlow: "Guided Electric Waves".*

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Annual General Meeting; at 5.30 p.m.—Prof. F. E. Simon, F.R.S.: "Has Low Temperature Physics any Practical Applications?"

BRITISH INSTITUTION OF RADIO ENGINEERS, SCOTTISH SECTION (in the Department of Natural Philosophy, The University, Edinburgh), at 7 p.m.—Mr. J. H. H. Merriman: "The London to Kirk o' Shotts Television Cable/Radio Link System".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

ROYAL SOCIETY OF MEDICINE, NEUROLOGY SECTION (at 1 Wimpole Street, London, W.1), at 8.15 p.m.—Dr. F. M. R. Walshe: "Thoughts on the Equation of Mind with Brain" (Hughlings Jackson Lecture).

UNIVERSITY OF LONDON (in the Swanley Hall, Wye College, Wye, Kent), at 8.15 p.m.—Sir David Brunt, F.R.S.: "The Basis of Microclimatology".*

Friday, December 5

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. W. J. Bray, Mr. R. L. Cooke and Mr. R. W. White: "The London-Wenvoe Experimental Radio Link for Television".

SOCIETY OF DYERS AND COLOURISTS, LONDON SECTION (at the Royal Society, Burlington House, Piccadilly London, W.1), at 6 p.m.—Dr. P. R. Peacock: "Food Dyes".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. F. J. Siddle: "New Fibres and the Problem of Colouring Them".

SOCIETY OF COSMETIC CHEMISTS OF GREAT BRITAIN (at the British Colour Council, 13 Portman Square, London, W.1).—Mr. Taylor: "Detergents".

Saturday, December 6

HOSPITAL PHYSICISTS' ASSOCIATION (in the Reid-Knox Hall, British Institute of Radiology, 32 Welbeck Street, London, W.1), at 10 a.m.—Discussion on "Ionization Chambers and various Aspects of their Use in the Measurement of X-Rays and Gamma-Rays".

BRITISH MYCOLOGICAL SOCIETY (at the Linnean Society of London, Burlington House, Piccadilly, London, W.1), at 12 noon.—Annual General Meeting; at 2.30 p.m.—Discussion on "Micro-Structure in relation to the Identification of Higher Fungi".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. J. W. Brailsford: "The Mildenhall Treasure".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BIOCHEMIST IN THE DEPARTMENT OF PATHOLOGY—The Area Pathologist, Royal Devon and Exeter Hospital, Exeter (December 6).

EDUCATIONAL PSYCHOLOGIST at the Guildford Child Guidance Clinic—The County Medical Officer, County Hall, Kingston-upon-Thames (December 6).

PHYSICIST (Senior Experimental Officer) to organize and supervise operations involving processing of active materials and to be responsible for accounting and movement control of active materials used by research and development group, and PHYSICISTS (Assistant Experimental Officers) to carry out radiation measurements with special reference to health hazards, at a Ministry of Supply establishment at Aldermaston—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.292/52A (December 6).

RADIO-BIOLOGIST FOR THE RADIOTHERAPY DEPARTMENT, for research in radio-biology in connexion with radiation in general—The Secretary and House Governor, Mount Vernon Hospital, Northwood, Middx. (December 6).

ENGINEERS at a Ministry of Supply establishment at Bickley, Kent:—Ref. C. 646/52A, for technical inspection of optical and survey instruments and allied equipment; Ref. C. 678/52A, for control of group engaged on above duties—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No. (December 13).

EXPERIMENTAL OFFICER AT THE NATIONAL PHYSICAL LABORATORY, Teddington, to assist in installation and running of large servo-connected differential analyser and design of other analogue computing equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.438/52A (December 13).

SCIENTISTS, Grade II, or SCIENTISTS, Grade III, or SCIENTIFIC TECHNICAL OFFICERS, Grade I (with degrees, or equivalent, in physics, chemistry, mathematics or mining engineering) on the staff of the Director of Scientific Control, to carry out environmental studies at collieries in connexion with a long-term field research into the occurrence and causes of pneumoconiosis—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting T/568 (December 20).

DIRECTOR OF THE DIVISION OF INDUSTRIAL HYGIENE, New South Wales Department of Public Health—The Agent General for New South Wales, 56 Strand, London, W.C.2 (January 12).

CHAIR OF GEOLOGY AND MINERALOGY—The Secretary of the University Council, Trinity College, Dublin (January 15).

READER IN THE DEPARTMENT OF SOIL SCIENCE AND CHEMISTRY, Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (January 15).

CHAIR OF CHILD HEALTH in the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 31).

LECTURER IN AIRCRAFT STRUCTURES AND DESIGN—The Secretary of University Court, The University, Glasgow (January 31).

AGRICULTURAL OFFICER and a BIOCHEMIST IN THE DEPARTMENT OF AGRICULTURE, Fiji—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CSC.63/49/01–2.

ASSISTANT (Grade A) IN PHYSICS—The Principal, Technical College, Queen Street South, Huddersfield.

ASSISTANT PHYSICIST (with honours degree in physics) in the RADIOTHERAPY CENTRE—The Group Secretary, War Memorial Hospital, Scunthorpe, Lincs.

ASSISTANT RESEARCH CHEMIST (organic) IN THE HOP RESEARCH DEPARTMENT—The Registrar, Wye College, Wye, Ashford, Kent.

COMBUSTION RESEARCH CHEMIST, to conduct both research and investigation of practical problems in the combustion of gas turbine and jet engine fuels and to assume some responsibility in the guidance and supervision of this work—The Chief, Personnel Branch, National Research Council, Ottawa, Ont., Canada; or The Chief Scientific Liaison Officer, National Research Council, Africa House, Kingsway, London, W.C.2.

EDUCATIONAL PSYCHOLOGIST (female, with an honours degree in psychology) to the Child Guidance Clinic—The Town Clerk, Town Hall, Bradford.

GEOLOGISTS (with a first- or good second-class honours degree in geology) in the combined Survey Department for Sarawak and North Borneo (C.S.D.6/92/51), and GEOLOGISTS (with a first- or good second-class honours degree in geology) in the British Solomon Islands Protectorate (C.S.D.6/45/51)—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting the appropriate Ref. No.

INSPECTORS OF MINES (with a degree or diploma of a recognized School of Metalliferous Mining, and two years postgraduate experience) in Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.99/14/01.

LECTURER (with honours degree in physiology) IN PHYSIOLOGY AND PHARMACOLOGY—The Registrar, Municipal College, Portsmouth.

LECTURER or ASSISTANT LECTURER IN AERODYNAMICS—The Head of Aeronautics Department, Imperial College of Science and Technology, South Kensington, London, S.W.7.

MINING GEOLOGIST (with a B.Sc. degree with honours in mining geology) in Sierra Leone—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27079/40.

PHYSICIST or ELECTRICAL ENGINEER at outstation of the Royal Aircraft Establishment, Woodbridge, Suffolk, to lead section engaged on application of radar to ballistics and other trials, including responsibility for conduct of trials, maintenance of ground radar equipment, plotting tables, etc., and development of techniques—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.291/52A.

PRINCIPAL SCIENTIFIC OFFICER at Sellafield, for work on health physics and other research problems associated with handling radioactive materials—The Ministry of Supply, Risley, Warrington, Lancs, quoting 393.

RESEARCH PLANNING OFFICERS at Salwick and Sellafield—The Ministry of Supply, Division of Atomic Energy (Production), Warrington, Lancs, quoting 385.

SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics, or equivalent, and an interest in properties of semiconductors) at the Ministry of Supply Telecommunications Research Establishment, Malvern, for research into methods of sensitization of photo-conductive cells, particularly lead selenide—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.298/52A.

SCIENTIST, Grade II or III (graduate chemist), in the Cannock Chase area—The Divisional Establishment Officer, National Coal Board, West Midlands Division, Himley Hall, Dudley, Worcs.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER AT THE ROAD RESEARCH LABORATORY, West Drayton, for research on properties and performance of bituminous road materials and related machinery—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting E.506/52.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Electrical Research Association. Technical Report L/T.255: Excitation Temperatures of Hydrogen Arcs. By H. Edels and J. D. Craggs. Pp. 18+8 plates. 12*s*. Technical Report W/T.24: Electrical Soil Warming for Salad Crops in Frames. By A. E. Canham. Pp. 9+1 plate. 9*s*. (Leatherhead: Electrical Research Association, 1951–1952.) [208

Department of Scientific and Industrial Research. Report of the Water Pollution Board with the Report of the Director of Water Pollution Research for the Year 1951. Pp. iv+56+4 plates. (London: H.M. Stationery Office, 1952.) 2*s*. 6*d*. net. [208

Friends of the Lake District. Report and News Letter. Pp. 20. (Ulverston: Friends of the Lake District, 1952.) [208

Reports on the Progress of Applied Chemistry. Vol. 36, 1951. Pp. 878. (London: Society of Chemical Industry, 1952.) [208

Agricultural Research Council. Foot-and-Mouth Disease Research: Interim Report. Pp. iv+12. (London: H.M. Stationery Office, 1952.) 6*d*. net. [258

Department of Scientific and Industrial Research: Forest Products Research. Bulletin No. 1: Dry Rot in Wood. Fifth edition. By K. St. G. Cartwright and Dr. W. P. K. Findlay. Pp. iv+36+8 plates. (London: H.M. Stationery Office, 1952.) 2*s*. net. [258

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 894, Vol. 245: The Imaging Properties of Electron Beams in Arbitrary Static Electromagnetic Fields. By P. A. Sturrock. Pp. 155–187. (London: Cambridge University Press, 1952.) 7*s*. 6*d*. [258

Problems of Power Transmission at Voltages above 225 kV. By François Cahen. Pp. 64. (London: British Electrical and Allied Manufacturers' Association, 1952.) 5*s*. [258

Department of Scientific and Industrial Research. Report of the Pest Infestation Board with the Report of the Director of Pest Infestation Research for the Year 1951. Pp. iv+36+4 plates. (London: H.M. Stationery Office, 1952.) 2*s*. net. [278

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 63, Part 4, No. 21: The Statistical Theory of Stiff Chains. By Dr. H. E. Daniels. Pp. 290–311. 3*s*. 6*d*. Vol. 63, Part 4, No. 22: Artificial Holograms and Astigmatism. By Dr. G. L. Rogers. Pp. 313–325+1 plate. 2*s*. 9*d*. Vol. 63, Part 4, No. 23: Studies in Practical Mathematics, 7, On the Theory of Methods of Factorizing Polynomials by Iterated Division. By Dr. A. C. Aitken. Pp. 326–335. 1*s*. 9*d*. Vol. 63, Part 4, No. 24: The Solution of a Functional Equation. By A. H. Read. Pp. 336–345. 1*s*. 9*d*. (Edinburgh and London: Oliver and Boyd, Ltd., 1952.) [278

Rapid Testing by Fluorescence. Pp. 12. (Slough: Hanovia, Ltd., 1952.) 1*s*. 6*d*. [288

Air Ministry: Meteorological Office. Geophysical Memoirs No. 88: Humidity of the Upper Troposphere and Lower Stratosphere over Southern England. By J. K. Bannon, Dr. R. Frith and H. C. Shellard. (M. O. 530c.) Pp. 36. (London: H.M. Stationery Office, 1952.) 2*s*. 6*d*. net. [288

University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, Academic Year 1950–1951. (Cmd. 8638.) Pp. 44. (London: H.M. Stationery Office, 1952.) 2*s*. net. [19

Memorandum on Non-Destructive Methods for the Examination of Welds. (T.29.) Pp. 64. (London: British Welding Research Association, 1952.) 5*s*. [19

Department of Scientific and Industrial Research. Forest Products Research, Bulletin No. 25: Identification of Hardwoods; a Lens Key. Pp. vi+122+8 plates. (London: H.M. Stationery Office, 1952.) 5*s*. net. [19

Anti-Locust Bulletin 12: Laboratory Experiments on Phase Differences in Locusts, by Dr. D. L. Gunn and Philip Hunter-Jones; Statistical Analysis of Data on the Selection Experiments, by D. E. Davies. Pp. ii+37. (London: Anti-Locust Research Centre, c/o British Museum (Natural History), 1952.) [19

Triplex Safety Glass Co., Ltd. Report of the Directors and Statement of Accounts for the Year ended 30th June 1952. Pp. 16. (London: Triplex Safety Glass Co., Ltd., 1952.) [29

National Physical Laboratory. Recent Developments and Techniques in the Maintenance of Standards. Pp. iv+100+15 plates. (London: H.M. Stationery Office, 1952.) 4*s*. 6*d*. net. [29

Ministry of Agriculture and Fisheries. Fishery Investigations, Series 2, Vol. 18, No. 2: Reproduction of Oysters in the Rivers Crouch and Roach, Essex, during 1947, 1948 and 1949. By Dr. E. W. Knight-Jones. Pp. 48. (London: H.M. Stationery Office, 1952.) 3*s*. 6*d*. net. [29

Journal of the Institute of Metals. Vol. 79, 1951. Editor: N. B. Vaughan. Pp. xxvii+514+61 plates. (London: Institute of Metals, 1951.) [29

Other Countries

Jamaica. Annual Report of the Department of Agriculture for the Year ended 31st March 1951. Pp. 25. (Kingston: Government Printer, 1951.) 2*s*. 6*d*. [258

Thirty-fifth Annual Report of the National Research Council of Canada, 1951–52. (N.R.C. No. 2780.) Pp. 46. (Ottawa: National Research Council of Canada, 1952.) [258

Publications of the Dominion Astrophysical Observatory. Vol. 9, No. 3: Wave-Lengths for Radial-Velocity Determinations based on Measures of One Hundred F- to M-Type Stars. By K. O. Wright. Pp. 167–180. 25 cents. Vol. 9, No. 2: A Spectrophotometric Study of the Shell Star ζ Tauri. By Anne B. Underhill. Pp. 139–166. 25 cents. (Ottawa: Queen's Printer, 1952.) [258

Papers of the Michigan Academy of Science, Arts and Letters. Editors: Eugene S. McCartney and Frederick K. Sparrow. Vol. 36 (1950). Pp. xii+352+21 plates. (Ann Arbor: University of Michigan Press: London: Oxford University Press, 1952.) 52*s*. net. [258

Bulletin of the American Museum of Natural History. Vol. 99, Article 5: Eocene Nautiloids of British Somaliland. By Otto Haas and A. K. Miller. Pp. 313–354+plates 21–31. (New York: American Museum of Natural History, 1952.) 1 dollar. [258

British Honduras. Report of the Forest Department for the Year ended 31st December 1949. Pp. 24. (Belize: Forest Department, 1952.) [278

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 30, Part 4: Studies of Pacific Island Plants, 10, The Meliaceæ of Fiji, Samoa and Tonga. By A. C. Smith. Pp. v+469–522. (Washington, D.C.: Government Printing Office, 1952.) 50 cents. [278

Bulletin of the American Museum of Natural History. Vol. 99, Article 6: Fossil Mammals from the Beginning of the Cenozoic in Brazil—Condylarthra, Litopterna, Xenungulata and Astrapotheria. By Carlos de Paula Conto. Pp. 355–395+plates 32–43. (Washington, D.C.: Government Printing Office, 1952.) 1 dollar. [278

Universidad Nacional del Tucuman. Publicación No. 641 (Instituto de Fisica, No. 31): Observacion acerca de la nueva definicion del amperio; el problemo de la tensiones de Maxwell. Por Ricardo Gans. Pp. 20. (Tucuman: Universidad Nacional, 1952.) [278

Annual Report of the Calcutta School of Tropical Medicine and the Carmichael Hospital for Tropical Diseases, 1948–50. Pp. 118. (Alipore: West Bengal Government Press, 1952.) [288

Bibliography of Scientific Publications of South Asia (India, Burma, Ceylon). No. 6, July–December 1951. Pp. xvi+124. (Delhi: Unesco South Asia Science Co-operation Office, 1952.) [288

Bulletin of the Madras Government Museum. New Series, Natural History Section, Vol. 1, No. 2, Part 6: The Mollusca of Krusadai Island (in the Gulf of Manaar), 1, Amphineura and Gastropoda. By S. Thomas Satyamurti. Pp. vii+266+34 plates. (Madras: Government Press, 1952.) 10.12 rupees. [288

Bericht über das Geobotanische Forschungsinstitut Rübel in Zürich für das Jahr 1951. Von. E. Rübel und W. Lüdi. Pp. 131. (Zürich: Geobotanische Forschungsinstitut Rübel, 1952.) [19

World Health Organization. Monograph Series No. 10: First International Symposium on Chemical Microbiology; Microbial Growth and its Inhibition. Pp. iv+285. (Geneva: World Health Organization; London: H.M. Stationery Office, 1952.) 15*s*.; 3 dollars; 12 Swiss francs. [19

National Academy of Sciences—National Research Council. Publication 208: Oceanography 1951; a Report on the Present Status of the Science of the Sea. By the Committee on Oceanography of the National Academy of Sciences. Pp. vii+36. (Washington, D.C.: National Academy of Sciences, 1952.) [19

Institut Royal Météorologique de Belgique. Contributions No. 5: Sur des observations à la limite ultraviolette du spectre du ciel nocturne. Par. F. W. Paul Gotz et M. Nicolet. Pp. 6. Publications No. 1: Comparison des radio-sondes du type 'Kew MK.II' par la méthode des éléments jumelés. Par Dr. L. Malet. Pp. 16. (Uccle-Bruxelles: Institut Royal Météorologique de Belgique, 1952.) [19

Departamento Forestal del Ecuador. Publicacion No. 14: La enumeracion y descripcion de los arboles y maderas. Por Dr. M. Acosta-Solis. Pp. 12. Publicacion No. 15: Formacion de la Xiloteca. Por Dr. M. Acosta-Solis. Pp. 22. (Quito: Departamento Forestal del Ecuador, 1952.) [19